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Impacts of cannabis on driving: An analysis of current evidence with an emphasis on Canadian data

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16. Abstract

The purpose of this document is to provide an overview of available research and evidence on the potential impact of cannabis on road safety in Canada. Six areas of relevance to this issue are considered: 1) research on the effects of cannabis on the skills necessary for safe driving; 2) research on the prevalence of cannabis use in Canada; 3) research on the prevalence of driving after cannabis use in Canada; 4) epidemiological studies of the impact of cannabis on collision risk; 5) means for assessing the presence of cannabis in drivers; and 6) legal initiatives in other jurisdictions to address the issue of cannabis and driving.

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16. Résumé

Le but de ce document est de fournir une synthèse de la recherche et des connaissances qui existent sur l'impact potentiel du cannabis sur la sécurité routière au Canada. Six éléments significatifs à ce sujet sont pris en considération : 1) recherche sur les effets de cannabis sur les aptitudes nécessaires à une conduite sûre; 2) recherche sur la prédominance de l'usage du cannabis au Canada; 3) recherche sur la prédominance de la conduite après usage du cannabis au Canada; 4) études épidémiologiques de l'impact du cannabis sur les risques de collision; 5) méthodes d'évaluation de la présence du cannabis chez les conducteurs; 6) initiatives juridiques prises dans d'autres juridictions pour aborder la question du cannabis et de la conduite.

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Executive Summary

Collisions remain a major cause of death and injury in Canada. Concerns about the role of cannabis in collision causation date back many years, although much less is known about the impact of this drug on collisions than alcohol. Among the reasons for this has been the much greater difficulty involved in measuring the presence and amount of cannabinoids compared to alcohol. However, there is renewed interest in this issue, stimulated in part by proposed legislative changes on the part of the Government of Canada to decriminalize possession of small amounts of cannabis. The purpose of this document is to provide an overview of available research and evidence on the potential impact of cannabis on road safety in Canada. Six areas of relevance to this issue are considered: 1) research on the effects of cannabis on the skills necessary for safe driving; 2) research on the prevalence of cannabis use in Canada; 3) research on the prevalence of driving after cannabis use in Canada; 4) epidemiological studies of the impact of cannabis on collision risk; 5) means for assessing the presence of cannabis in drivers; and 6) legal initiatives in other jurisdictions to address the issue of cannabis and driving.

A substantial body of research assessing the effects of cannabis on human performance exists, and several authoritative reviews of this literature have been published. The evidence is very clear that a moderate or higher dose of cannabis impairs driver performance and several of the skills necessary for safe driving. Some authors have reported that the largest degree of impairment is observed with tasks involving attention, tracking and psychomotor skills. As with alcohol and other psychoactive drugs, tolerance may be observed to some of the effects of cannabis in experienced users. The effects of using cannabis in combination with alcohol, which

seems to occur frequently among cannabis users, appear to be either additive, in which the effects are roughly equivalent to adding the effects of the two drugs together, or multiplicative, in which the effects of the drugs taken together are greater than an addition of the effects of the two drugs.

After alcohol, cannabis is the most widely used psychoactive drug in Canada. Use of the cannabis was relatively uncommon until the 1960s, and since then has increased substantially. In Canada, only a small number of national surveys have examined cannabis use. In a 1994 survey of Canadians aged 15 and over, about 1/3 of respondents reported using cannabis at some point in their lives while 7.3% reported using cannabis in the previous year. Current usage rates were highest in British Columbia and lowest in Ontario. Trend data from Ontario reveal that cannabis use has been increasing among high school students since 1991, and has reached levels last seen in the late 1970s. Among adults the trends are much less clear, although the proportion of users in recent years is higher than observed in the early 1990s.

Information on cannabis use and driving is unfortunately rare, but some data are available. In the general driving population, the proportion that report driving after cannabis use in the previous year is low, with recent estimates ranging from 1.5% to 1.9%. However, it is clear that there are subgroups of the driving population for whom driving after cannabis use is much more common. Cannabis users and younger drivers are much more likely to report driving after cannabis use, and a recent study of Ontario students found that 19.3% of drivers in high school reported driving within an hour of using cannabis in the previous year.

Many studies internationally have examined the prevalence of cannabinoids in drivers who have been injured or killed in motor vehicle collisions. These studies reveal that cannabinoids are the drugs most commonly found after alcohol in these individuals. Evidence from Canada is consistent with this observation; two recent studies detected cannabinoids in 13.9% and 19.5% of samples of seriously injured and fatally injured drivers, respectively. For several methodological reasons it is much more difficult to assess the contribution of cannabis to collision risk, for example, it is very difficult to obtain appropriate control samples not involved in collisions. In the most methodologically sound study reported to date, Quebec researchers found that cannabis was associated with a doubling of the risk of being involved in a fatal collision. However, other studies present more variable results. Other research paradigms can also provide important evidence here. For example, recent studies with individuals seeking treatment for substance abuse have found that individuals who report a problem with cannabis have elevated collision histories in the few years preceding treatment entry.

When cannabis enters the body, THC and other cannabinoids are widely distributed to all tissues. Cannabinoids accumulate in fatty tissues and are slowly released into other body compartments. Metabolites can be found in the urine for up to 12 days after a single dose of THC and for a month or two after heavy use. For this and other reasons research has frequently observed a poor correlation between plasma or urine concentrations and the pharmacological effects of the drug. However, more recent studies have been able to link plasma concentrations with pharmacological effects with more accuracy. Several methods have been proposed or used to assess the presence of cannabinoids in drivers, including breath, blood, urine, saliva and sweat tests, and behavioural examinations. While blood tests are the 'gold standard,' they are very

invasive and create logistic and legal concerns. Urine tests may not differentiate between cannabis use that occurred very recently and use that occurred days or even weeks before. Saliva and sweat tests and behavioural examinations are promising procedures that are being used or assessed in many jurisdictions.

The Criminal Code of Canada permits police to lay a charge of impaired driving (section 253a) if they believe a person's ability to operate a vehicle is impaired by 'alcohol or a drug'. British Columbia and some other provinces have begun, or plan to begin, training police officers as Drug Recognition Experts. Canada's current legal approach to cannabis and driving is similar to that taken in many jurisdictions. However, in several jurisdictions legislation has been planned or introduced to create specific offences of driving under the influence of cannabis and other drugs (e.g., Germany, Belgium, New York, Nevada, New South Wales).

Impacts of cannabis on driving: An analysis of current evidence with an emphasis on Canadian data

1. Introduction

While many advances have been made in road safety in Canada, collisions remain as the seventh leading cause of person years of life lost (PYLLs) in this country, and among those aged 0-19 are the third leading cause of PYLLs (National Cancer Institute of Canada, 2001). The substantial effect of alcohol on road safety has long been recognized, and a variety of important initiatives to combat this problem have been introduced with some measurable success (Mann et al., 2002; Asbridge et al., in review). Concerns about the effects of other psychoactive substances on driving skills and collision rates date back many years (e.g., Organisation for Economic Cooperation and Development, 1968; Smart et al., 1969) but for several reasons much less is known about this issue.

The illicit drug most commonly used in Canada is cannabis (Adlaf et al., 1994). Cannabis use was relatively uncommon in this country in the early part of the 20th century. In the 1960s, use increased substantially, but beginning in the early 1980s began to decline (Adlaf et al., 1994). However, cannabis use has had a resurgence in recent years among young people (Adlaf and Paglia, 2001) and possibly adults as well (Adlaf et al., 2001). There are indications in available research that driving after cannabis use increases risk for collisions (Dussault et al., 2002). Cannabis is also associated with impaired performance on laboratory tasks (Moskowitz, 1985), and after alcohol it is the drug most often found in dead and injured drivers (Cimbura et al., 1990; Stoduto et al., 1993).

The legal status of cannabis is also under public discussion. For many years cannabis possession has been a criminal offence. However, in September 2002, the Senate Special Committee on Illegal Drugs called for the legalization of cannabis. As well, medicinal use of cannabis has recently been permitted for a small number of individuals who apply for, and are granted, permission for use of cannabis for medical reasons. In December 2002, the House of Commons Special Committee on the Non-medical Use of Drugs released its report calling for decriminalization of possession of small amounts of cannabis. On May 27, 2003, the government introduced the Cannabis Reform Bill (C-38) that replaces the current court process and resulting criminal penalties with alternative penalties for possession of 15 grams or less of marijuana or one gram or less of cannabis resin (hashish). This bill makes the offence punishable by a fine through a ticket issued by a law enforcement officer.

One concern that has been expressed in this context is that cannabis use may exert deleterious effects on driving skills and collision risk, and that this must be taken into consideration in any efforts to change the legal status of cannabis. As noted above, there are also indications of increasing prevalence of use of cannabis among young people and possibly adults as well. One recent study found that, among Ontario Secondary School students, the proportion reporting driving after using cannabis was actually higher than the proportion reporting driving after using alcohol (Adlaf et al., 2003).

It is therefore clear that driving under the influence of cannabis (DUIC) may be an increasingly important issue from a public policy and road safety perspective. Thus there is a clear need to assess the evidence related to this issue to determine our current level of knowledge, in order to provide an evidence-based perspective to discussions of the magnitude of the DUIC problem and whether or not there may be need for legislative or program action.

Objectives

The principal objective of this document is to provide an overview of the available research and evidence on the potential impact of cannabis on road safety in Canada. To achieve this goal, the report provides evidence in the following areas:

1) An overview of current scientific literature on the effects of cannabis on the skills necessary for safe driving;
2) A review of current scientific evidence on the prevalence of cannabis use in Canada;
3) A review of current scientific evidence on the prevalence of driving after cannabis in Canada;
4) A comprehensive review of current scientific evidence on the effects of cannabis on collision risk;
5) A description of the means for assessing the presence of cannabis in drivers; and
6) A description of legal initiatives in other countries to deal with the issue of driving under the influence of cannabis.

Methodology

This project involved both selective and comprehensive literature review. The report provides a comprehensive review of current scientific evidence on the effects of cannabis on collision risk, on the prevalence of cannabis use in Canada, and on the prevalence of DUIC in Canada. A selective review was undertaken for the remaining topics. However, care was taken to ensure that the information used in this report was representative of current scientific opinion on the issues involved. A comprehensive search of computerized databases (e.g., Medline, Psychlit, Dalctraf) was undertaken, and available literature was obtained. As well, proceedings of selected

conferences relevant to the topic (e.g., International Conference on Alcohol, Drugs and Traffic Safety) were searched. A particular effort was made to access reports available on use of cannabis and DUIC use based on Canadian data derived from population surveys, such as the Ontario Student Drug Use Survey (e.g., Adlaf and Paglia, 2001), the CAMH Monitor (e.g., Adlaf and Ialomiteanu, 2001) and the National Alcohol and Other Drugs Survey (e.g., Ogborne and Smart, 2000).

2. Effects of Cannabis on Performance

Over the years, a substantial amount of information has accumulated on the effects of cannabis on human performance. Of particular interest here are those studies most relevant to the possible effects of the drug on driving behaviour. According to Maes et al. (1999), these tasks can be grouped in the following categories: attention tests (simple and divided attention); vigilance tests (ability to sustain attention); auditory and visual tests (visual acuity, accommodation to darkness/light); reaction time (simple and choice reaction time); cognitive tests (e.g., Digit/symbol substitution test, Stroop word/colour test, Letter cancellation test); memory tests; mental arithmetic; flicker fusion test; visual-motor coordination tests; body sway; physiological measurements (EEG, eye movements, pulse, blood pressure); and self-awareness measures. Additionally, studies may involve simulated or actual driving tasks.

Several comprehensive reviews of this literature have appeared, and the results appear to be very consistent. A consistent conclusion is that the acute effects of a moderate or higher dose of cannabis impairs the skills related to safe driving and injury risk. Moskowitz (1985) concluded that marijuana use impairs driver performance under a variety of experimental conditions. Berghaus and Guo (1995) conducted a meta-analysis of 60 studies and concluded that marijuana causes impairment of every performance area connected with safe driving of a vehicle, such as tracking, psychomotor skills, reaction time, visual functions, and attention. Of these performance criteria, the most deterioration from marijuana use was found for measures of attention (e.g., the Continuous Performance Task), tracking (e.g., the Pursuit Rotor task) and psychomotor skills (e.g., simple reaction time)(Berghaus and Guo, 1995; Coambs and McAndrews, 1994). Similar conclusions have been reached by other reviewers (Ashton, 2001; Hollister, 1998; O'Kane et al., 2002; Maes et al., 1999; Smiley, 1999). Some authors have

postulated that the various cognitive impairments mentioned previously are related to duration of drug use (Hall and Solowij, 1998). Johns (2001) notes that cannabis use can occasionally result in short-term psychiatric distress and even psychotic states, and that cannabis may provoke relapse and aggravate existing symptoms in people with major mental illnesses such as schizophrenia. In addition, potential withdrawal effects of heavy, long-term cannabis use such as restlessness, insomnia, and anxiety also could influence injury risk (Ashton, 2001).

Smiley (1999) concluded that marijuana impairs skills and ability. However, she noted that drivers are aware of this impairment, which may prompt them to slow down and drive more cautiously, suggesting that experienced cannabis users can compensate for the deleterious effects of cannabis on driving skills. This compensation for the effects of the drug is a form of tolerance to its effects. Tolerance is defined as a reduction in response to a particular dose of a drug with repeated administration, or the requirement that larger amounts are needed to obtain the same drug effect (Kalant, Leblanc and Gibbins, 1973). Tolerance to cannabis over repeated administrations is observed in animal studies with cannabis (Ashton, 2001), but very little systematic research on cannabis tolerance in humans is available. When considering the extent to which tolerance to cannabis might influence drivers, it is useful to consider possible parallels between tolerance to cannabis and tolerance to alcohol. Tolerance is observed for both drugs, and substantial research has addressed the issue of alcohol tolerance in humans (e.g., Vogel-Sprott, 1992). The impairing effect of alcohol on psychomotor tasks is readily observed. However, under conditions where reinforcement is provided for non-impaired performance tolerance will develop over a series of drinking sessions (Mann and Vogel-Sprott, 1981; Beirness and Vogel-Sprott, 1983), and the extent of tolerance development is related to awareness of impairment and efforts to compensate (Mann et al., 1983). However, impairment returns when reinforcement

contingencies are withdrawn (Mann and Vogel-Sprott, 1981; Zack and Vogel-Sprott, 1993). This return of impairment indicates that even tolerant or experienced users will display impairment of psychomotor performance. Thus, the same process that Smiley (1999) suggested may alleviate performance deficits in experienced cannabis users has been extensively studied with human subjects in laboratory research with alcohol. These studies indicate that even in those who learn to compensate for a drug's impairing effects, substantial impairment in performance is still observed under conditions of general task performance (i.e., when no contingencies are present to maintain compensated performance).

Other researchers have investigated the effects of cannabis combined with alcohol on laboratory performance measures. These studies have been stimulated in part by the apparent frequency with which both drugs are used together (Jonah, 1990; Walsh and Mann, 1999; Cimbura et al., 1990; Stoduto et al., 1993). In general, these studies typically, but not always, reveal that the effects of cannabis plus alcohol are greater than the effects of cannabis alone (Liguori et al., 2002; Chait and Perry, 1994). The research suggests that the effects of combining cannabis with alcohol on skills necessary for safe driving such as visual search and road tracking are either additive, in which the effects of both drugs together are roughly equivalent to adding the effects of the two together, or multiplicative, in which the effects of the two drugs together are greater than the effects of the two individually (e.g., Laemers and Rameakers, 2000; Robbe, 1998). In reviewing this literature, O'Kane et al. (2002) observed that alcohol's effects are strongest on integrative tasks while the effects of cannabis are strongest on tasks requiring attention and psychomotor skills.

Some limitations of laboratory studies

In general, laboratory studies have found that the ingestion of cannabis is related to performance deficits. These studies are highly useful for determining the pharmacological effects of drugs, but there are difficulties in generalizing the results of these studies to real world conditions. For example, the research methodology in laboratory studies often involves completing reaction time or other cognitive tasks to the best of one's ability. As a result, these studies are more likely measuring the effect of drugs on peak performance as opposed to typical performance. These studies also may not adequately address the impact on performance of long term use and abuse a drug. As well, doses used in laboratory studies tend to be restricted and thus the results are not helpful in understanding the effect of very large doses of cannabis on performance.

3. Prevalence of Cannabis use in Canada

Little information is available on the prevalence of cannabis use in Canada prior to the 1960s (Smart and Fejer, 1973). However, in that decade, cannabis use increased substantially. While a variety of possible sources of information on cannabis in the Canadian population have been used over the years, including such measures as amounts of the drug seized by police and the number of individuals prosecuted by the courts for cannabis offences, the most direct and the most accurate measures of the prevalence of cannabis use are those derived from surveys. Although cannabis is an illegal drug and there are concerns that survey responses may be influenced by its legal status, research demonstrates that respondents to anonymous surveys, where there are no adverse consequences involved, generally provide valid responses (Harrison et al., 1993; Turner et al., 1992).

Smart and Fejer (1973) presented one of the very first estimates of the prevalence of cannabis use in a Canadian population, based on a survey of a representative sample of residents of Toronto conducted in 1971. They found that 12.2% of males and 5.5% of females had used cannabis at least once in the preceding year. The prevalence of use differed substantially by age group and gender. Among males, 41.5% of those aged 18-25, 20.8% of those aged 26-30, and 1.8% of those aged 31 and over had used cannabis in the preceding year. Among females, 20.0% of those aged 18-25, 6.3% of those aged 26-30, and 1.8% of those aged 31 and over had used cannabis in the previous year. These data clearly demonstrate that, by the end of the 1960's, cannabis use had become very common among young people.

Ogborne and Smart (2000) reported on cannabis use in the general population of Canada aged 15 and over based on the National Alcohol and Other Drugs Survey conducted in 1994. This survey was the largest representative survey with information on cannabis use ever made in

Canada, with a sample size of 12,155. Use of cannabis at that time was relatively uncommon, but not rare. Only 7.3% of respondents reported using cannabis in the preceding year, and 2.0% reported using it as often as once per week. However, nearly a third (29%) reported that they had used cannabis at least once in their lives. Substantial regional differences were observed, as noted in Table 1, with the proportion reporting use at least once in the past year ranging from a low of 4.9% in Ontario to a high of 11.4% in British Columbia.

Table 1: Use of cannabis in the past year, regions of Canada, 1994

	Maritimes	Quebec	Ontario	Prairies	British Columbia
Percent reporting use in the past year	*5.9%*	*8.5%*	*4.9%*	*8.1%*	*11.4%*

Data derived from Ogborne and Smart, 2000.

While these data provide a valuable perspective on the use of cannabis across Canada, unfortunately there is little information on other important issues, such as change in rates of use over time. However, in Ontario a series of surveys has been conducted over the past 20 years that allow a picture of current use and changes in use over time in that part of the country.

The Use of Cannabis in Ontario

Repeated cross-sectional surveys conducted in Ontario by the Centre for Addiction and Mental Health provide the most comprehensive picture of the use of cannabis and other drugs use in Canada. These surveys have been conducted among the student population and adult population since the late 1970s (Adlaf and Ialomiteanu, 2002; Adlaf and Paglia, 2001).

Table 2 presents a summary of recent data on the use of cannabis and other drugs (any use in the past year) among students in grades 7 and 12 (Adlaf and Paglia, 2001), and among

adults aged 18-29 (young adults), 40-49 (the middle-aged) and 65 and over (seniors) (Adlaf and Ialomiteanu, 2001). Cannabis is the most widely used illicit substance, with nearly half of grade 12 students reporting cannabis use at least once in the past year. It is worth noting that by grade 12 most students will have reached the age when they will be eligible to drive. Use of cannabis drops with increasing age, however, and is used by less than 2% of seniors. Use of other illicit drugs is much less common than the use of cannabis, with highest levels occurring for Hallucinogens and Ecstasy among grade 12 students. Not surprisingly, alcohol is the most commonly used substance.

Table 2: Percent of respondents reporting substance use within the past 12 months among students and adults in Ontario by selected grade or age group, 2000/2001

	Alcohol	Cannabis	Cocaine	Hallucinogen	Ecstasy	Heroin	Any illicit drug
Students							
Gr. 7	*36.1*	*5.1*	*2.4*	*0.9*	*0.9*	*0.9*	*10.6*
Gr. 12	*80.0*	*43.5*	*3.5*	*20.5*	*9.2*	*S*	*43.5*
Adults							
18-29	*85.7*	*28.2*	*4.4*	*Na*	*7.3*	*Na*	*Na*
40-49	*79.2*	*6.4*	*S*	*Na*	*Na*	*Na*	*Na*
65+	*61.9*	*1.5*[a]	*S*	*Na*	*Na*	*Na*	*Na*

S - Estimate under 1% or unreliable Na - Not available
Sources - Students: Adlaf and Paglia, 2001; Adults: Adlaf and Ialomiteanu, 2001
[a] age group is 50+ for cannabis data

Table 3 presents sex differences in the reported use of cannabis, alcohol and other drugs in the past 12 months. While some differences appear, these are not large, and it is clear that cannabis and other drug use is not restricted to either males or females.

Table 3: Percent of respondents reporting substance use within the past 12 months among students (in Grades 7, 9, 11, 13) and adults in Ontario by gender, 2000/2001

	Alcohol	Cannabis	Cocaine	Ecstasy	Any illicit drug
Students					
Males	*66.3*	*33.7*	*4.6*	*6.7*	*33.5*
Females	*65.0*	*26.0*	*3.9*	*5.4*	*31.4*
Adults					
Males	*81.7*	*14.3*	*1.9*	*2.6*	*Na*
Females	*73.0*	*7.7*	*S*	*1.0*	*Na*

S - Estimate under 1% or unreliable Na - Not available
Sources - Students: Adlaf and Paglia, 2001; Adults: Adlaf and Ialomiteanu, 2001

Trends in Cannabis Use Over Time

Table 4 presents information on the proportion of students in Grades 7, 9, 11 and 13 who report using cannabis and alcohol between 1977 and 2001 (Adlaf and Paglia, 2001). While

Table 4: Trends over time in cannabis and alcohol use among Ontario students in Grades 7, 9, 11, 13

	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995	1997	1999	2001
Alcohol	*76.3*	*76.9*	*75.3*	*71.7*	*69.8*	*68.1*	*66.2*	*58.7*	*56.5*	*58.5*	*59.6*	*65.7*	*62.6*
Cannabis	*25.0*	*31.7*	*29.9*	*23.7*	*21.2*	*15.9*	*14.1*	*11.7*	*12.7*	*22.7*	*24.9*	*29.2*	*28.6*

Source – Adlaf and Paglia, 2001

cannabis is used by a smaller proportion of students than alcohol; it is still used by a substantial minority of students. There have been important changes in the use of cannabis over time. The general trend appears to have been one of reduced use of cannabis and alcohol from the late 1970's to the early 1990's. The proportion reporting use of cannabis declined from a peak of 31.7% in 1979 to 11.7% in 1991. However, since the mid-1990's self-reported use of both substances has increased, with 28.6% reporting cannabis use in 2001.

Table 5 presents data since 1977 on the proportion of the adult population (age 18 and above) who report using cannabis, drinking alcohol, or using cocaine at least once in the preceding 12 months (Adlaf and Ialomiteanu, 2001). Cannabis use has continued

Table 5: Trends over time in alcohol, cannabis and cocaine use among Ontario adults

	1977	1982	1984	1987	1989	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cannabis	*8.1*	*8.2*	*11.2*	*9.5*	*10.5*	*8.7*	*6.2*	*Na*	*9.0*	*Na*	*8.7*	*9.1*	*8.6*	*10.4*	*10.8*
Alcohol	*79.9*	*77.7*	*84.5*	*83.1*	*82.6*	*80.3*	*86.6*	*83.3*	*82.1*	*84.4*	*79.3*	*79.9*	*77.1*	*79.1*	*77.2*
Cocaine	*Na*	*Na*	*1.7*	*1.8*	*2.1*	*1.6*	*Na*	*Na*	*S*	*Na*	*S*	*Na*	*S*	*Na*	*1.2*

S - Estimate under 1% or unreliable Na - Not available
Source – Adlaf and Ialomiteanu, 2001

among a much smaller proportion of the adult population than among students. Alcohol is used by the large majority of the adult population, while the use of cocaine is reported by only a very small percentage. The trends among adults are not as clear as those among the student population. For example, the proportion reporting use of alcohol has been relatively consistent, with perhaps a slight increase to the early 1990s followed by a slight decrease. Among users of cannabis and cocaine, enduring trends over time cannot be ascertained.

4. Prevalence of Cannabis Use and Driving in Canada: Estimates from Survey Data

Survey data on the prevalence of driving under the influence of cannabis are available. In the first reported data from the general population in Canada, Jonah (1990) reported on the prevalence of driving after use of cannabis at least once in the preceding 12 months. The survey included 9943 persons aged 16-69, obtained through random digit dialing. Jonah found that the prevalence of DUIC varied with age, as summarized in Table 6. While the prevalence of DUIC was relatively low, it was higher in younger age groups. Jonah also observed that DUIC was significantly associated with a variety of other risk behaviours, such as driving after drinking, use of illicit drugs other than cannabis, and collision involvement.

Table 6: Prevalence of DUIC by Age in Canada, 1988

	Age Groups					
	16-19	**20-24**	**25-34**	**35-44**	**45-64**	**65+**
% reporting DUIC in the previous 12 months	*4.3*	*5.8*	*3.0*	*0.6*	*0.0*	*0.3*

Data derived from Jonah, 1990.

Walsh and Mann (1999) reported information on the incidence of DUIC in a representative sample of the Ontario adult population surveyed in 1996/97. Among all drivers, 1.9% reported DUIC in the previous 12 months. Several factors influenced the likelihood of reported DUIC, including gender, age, marital status and education level. DUIC was most frequently seen in younger age groups, with 9.3% of the youngest age group (18-19) reporting the behaviour. DUIC was more common among men (3.0%) than women (0.8%), more common

among those never married (4.7%) than among those married (0.9%) or previously married (2.1%). It was also least common among those with a university degree. Among cannabis users, DUIC appeared to be a relatively common behaviour; 22.8% reported DUIC, and the probability of the behaviour was significantly influenced by gender and education level. As well, DUIC and drinking-driving were strongly related in this sample.

The observation that DUIC was more common among younger respondents was recently extended by Adlaf, Mann and Paglia (2003). These investigators assessed DUIC among respondents to the 2001 administration of the Ontario Drug Use Survey (OSDUS). Among students with a drivers licence in grades 10-13, 19.3% reported driving within one hour of using cannabis at least once in the preceding year; this proportion was higher than the proportion that reported driving within an hour of two or more drinks (15.0%). Males were significantly more likely than females to report DUIC (23.8% versus 13.5%).

Beirness, Simpson and Desmond (2003) reported on DUIC in a survey of Canadian drivers. Among respondents, 5.1 % reported using marijuana, and 1.5% reported DUIC at least once in the preceding 12 months. These authors also noted that males and respondents under 30 were most likely to report DUIC, and also that there was a strong relationship between DUIC and driving after drinking.

Recently, the first report on trends over time in cannabis use and driving in Canada appeared (Adlaf, Paglia and Mann, 2003). These authors compared the proportions of Ontario adults reporting DUIC in a representative sample of the Ontario population surveyed in 2002 with those reported by Walsh and Mann (1999). A trend for an increase over time was observed, with the proportion of adult drivers reporting DUIC increasing from 1.9% in 1996/97 to 2.7% in

2002. The authors note, however, that this increase is not statistically significant and recommend further monitoring of this trend.

5. Epidemiological Studies on Collision Risk Associated with Cannabis Use

In order to arrive at an adequate understanding of the influence of cannabis on collision risk, epidemiological studies are necessary. In the past two decades, numerous such studies have been published on the involvement of cannabis collisions. In this review of the literature, conclusions from two types of studies will be drawn: (I) descriptive and analytic epidemiological studies on the prevalence of cannabis use through drug testing in injured drivers, (II) studies of collision risk of clinical samples of cannabis users. The purpose of this section is to review the available empirical research in order to assess the risks that cannabis may pose for traffic collisions. This assessment of risk is central to our understanding of the role of cannabis in traffic safety in Canada. If cannabis does not influence collision risk, then there is no reason to be concerned about its effects on road safety. However, if cannabis does increase collision risk, this information provides the central impetus for efforts to improve road safety through policies and programs to reduce DUIC. Thus, a comprehensive analysis of the research from Canada and internationally will be presented here. Strengths and limitations of these studies are addressed.

I. Studies using drug tests of injured drivers to detect cannabis metabolites

Studies that obtained drug tests of urine, blood or saliva from injured drivers are included in this section. Also included are studies of special populations where drug tests were taken of those suspected of driving under the influence or reckless driving. A large number of descriptive studies have been conducted where the blood or urine of injured drivers has been analysed for the presence of cannabis metabolites. Twenty-eight studies were found. The research

methodologies and results in terms of the proportion testing positive for cannabis metabolites are described in Table 7a.

There have been many epidemiological studies that have reported drug tests of fatally and non-fatally injured drivers. The percent of fatally injured drivers testing positive for cannabis ranged from 1.4% to 27.5% (Mean=10.7%); while for non-fatally injured drivers the percent ranged from 5% to 15.7% (Mean=11.5%) (Macdonald et al., in review-b). Three of these studies were conducted in Canada. Two analysed fluids from fatally injured drivers (Cimbura et al., 1990; Mercer and Jeffery, 1995). Cimbura et al. (1990) found 10.9% of fatally injured Ontario drivers and 7.6% of pedestrians tested positive for cannabis. In British Columbia, 13% of fatally injured drivers tested positive for cannabis (Mercer and Jeffery, 1995). In the third, Stoduto et al. (1993) found that 13.9% of injured drivers and motorcyclists admitted to a trauma unit in Toronto tested positive for cannabis.

The prevalence rates for cannabis are highest for the special driver populations, that is, those suspected of drug or alcohol impairment or reckless driving. The percent of impaired or reckless drivers testing positive for cannabis ranged from 7.4% to 65.9% (Mean=34.6%). In a Canadian study (Peel and Jeffrey, 1990), 20% of drivers impaired by alcohol also tested positive for cannabis.

Although many studies have been conducted on the prevalence of positive drug tests among injured drivers, few studies incorporated control groups so that assessments of relative risks could be estimated. The best methodological studies are analytic epidemiological studies that utilize either the case-control method (Ferrara et al., 1990; Meulemans et al., 1996; Marquet et al., 1998; Dussault et al., 2002) or methods used to ascribe crash responsibility (Drummer, 1995; Longo et al., 2000a,b; Dussault et al., 2002) (see Table 7a). Statistical significance was

found in two studies for odds ratios for drivers testing positive for cannabis in collisions versus controls testing positive. These studies are reviewed in greater detail below.

In a case-control study conducted in France, 296 injured drivers at emergency room departments and 278 non-injured control patients matched by age were urine tested for the presence of cannabis (Marquet et al., 1998). Methodologically, this study is unique among case-control studies in the field because consent was not required for urine tests of either cases or controls and therefore the results are free of selection biases. Results indicated that all drivers testing positive for cannabis were no more likely than controls to be involved in collisions. However, when the analyses were restricted to women only, the relationship became significant (Marquet et al., 1998).

Preliminary findings of another case-control study have recently been reported for 354 fatally injured drivers and 5,931 roadside controls in Quebec (Dussault et al., 2002). The odds ratio was statistically significant and indicated that fatally injured drivers were 2.2 times more likely to test positive for cannabis than controls. However, this result should be treated cautiously due to the possibility of systematic bias in the study. Little bias is likely for the proportion testing positive among the fatal drivers (19.5%); however, for the control group, consent was required by participants to provide a urine test. Only 49.6% of controls agreed to provide a urine sample. The authors used saliva samples to assess the degree of possible bias, with the rationale that the reason drivers refused both urine samples and saliva sample would be the same (fear of detection). The participation rate for saliva tests was 84.6%, which suggests that a large proportion of people found urine tests more invasive. Assuming that 50% of the people that did not provide a saliva sample were positive for cannabis, the odds ratio would become insignificant at 1.3. Furthermore, the responsibility analysis for cannabis, which was not subject

to non-respondent biases, was not significant. Therefore, while this study is the most comprehensive case-control study of the effects of cannabis on collision risk, because of concerns about potential bias in the control group the results must be treated cautiously.

Meulemans et al. (1996) conducted a study where urine tests were taken from injured drivers at emergency rooms in Belgium. The authors examined injury severity of those in crashes. Positive cannabis metabolites was not significantly related to injury severity.

In a case-control study by Ferrara et al. (1990), drug tests were conducted on 5,000 injured drivers in Italy. The proportion of injured drivers with positive drug metabolites was compared to a group of 500 drivers not involved in crashes. Although the proportion of those testing positive for cannabis was higher for injured drivers than controls, no statistical analyses were reported, making interpretation of the findings problematic.

Two studies conducted in Australia are unique in that blood samples were taken rather than urine tests. Blood samples permit analyses of both the active and inactive ingredients of THC and are the best approach for determining likely cannabis impairment. As well, the Road Traffic Act of South Australia indicates that anyone attending a hospital for an automobile crash must provide a blood sample. Drummer (1995) examined the blood samples of driver fatalities linked with traffic reports in an Australia study. Interestingly, those testing positive for cannabis were less likely than those without drugs to be judged to be responsible for crashes (odds ratio =.6). The other Australian study using responsibility analysis obtained drug tests from 2,500 injured drivers (Longo et al., 2000a,b). The culpability analysis approach involved an objective scoring criterion of culpability and analyses of blood samples of drivers in the crashes. As in the the Drummer study, Longo et al. (2000a,b) found that a lower percentage of drivers who tested

positive for THC were culpable than drug-free drivers, though the difference was not statistically significant.

These studies are the only epidemiological studies found that incorporated controls or comparison groups to assess the risk of collisions for cannabis use, and therefore are the only studies where risks can be evaluated. Of the case-control studies, the study by Marquet presents the fewest possible threats to validity. The studies using responsibility analyses are also methodologically rigorous; however, this approach requires very large sample sizes for enough statistical power to obtain significance because fatal drivers in general are more likely to have been responsible for the crashes than non-fatally injured drivers (Terhune et al., 1992). Overall, these epidemiological studies have not demonstrated conclusively that cannabis is a risk factor for crashes.

This conclusion is supported by several review articles published in the past 15 years on the epidemiological research evidence on the role of cannabis in collisions (Bates and Blakely, 1999; Chesher, 1995; Christopherson and Morland, 1997; de Gier, 2000; Ferrara et al., 1994; Hunter et al., 1998; Morland, 2000; Robbe and O'Hanlon, 1993; Vingilis and Macdonald, 2002; Macdonald et al., in review-b). The majority of literature reviews on cannabis and driving have argued that there is not sufficient scientific evidence to conclude that cannabis use is a risk factor for crashes but better studies are needed. Conclusions by Bates and Blakely (1999) are typical of most reviews on this subject. They concluded that although there is no clear evidence that consumption of cannabis increases the risk of traffic fatalities or injuries, cannabis cannot be excluded as a risk factor for traffic crashes. Morland (2000) suggested that cannabis use does constitute a safety risk for crashes. In arriving at these conclusions, he placed greater emphasis on the pharmacological effects of cannabis, but he does acknowledge an absence of concrete

evidence showing a link between cannabis use and crashes from analytical epidemiological studies. The failure of studies to obtain significance may be due to methodological limitations, which are described in more detail in the discussion section of this paper.

II. Studies using clinical samples of cannabis abusers in treatment

The characteristics of studies using clinical samples of cannabis abusers in treatment are summarized in Table 7b. We know from existing studies that clinical substance abuse populations are likely to drive after using cannabis. In a study of cannabis users in treatment, 62% reported driving at least once after using the drug (Albery et al., 1999). In a study of those in treatment for alcohol, cannabis or cocaine abuse, 63% reported driving after use of cannabis (Macdonald et al., in review-a).

Few studies exist that examine collision risks experienced by clinical samples of individuals receiving treatment for cannabis. In the first of these studies, Smart and Schmidt (1969) observed elevated collision rates in abusers of one or more drugs other than alcohol, but the sample was very small (n=30). In another study of 144 male substance abusers aged 21-40, Mann et al. (1993) examined collision rates in the year before entry into treatment and compared these rates to collision rates in the general male population of the same age. The subjects estimated that about 50% of their collisions in the preceding year occurred while they were under the influence of alcohol and/or drugs. As well, results suggested that the frequency of any substance use, as opposed to the use of specific substances, predicted collision involvement and significant post-treatment reductions were found in moving violations, DWI convictions, and total collisions (Mann et al., 1995).

A recent study examined the driving records of a large sample of cannabis abuse clients in treatment (Macdonald et al., in review-c). This study utilized blind linkage procedures to avoid non-respondent bias, and compared the clinical sample to a randomly selected, frequency-matched (age, gender, location) control group of drivers. Significant elevations in collisions were found for abusers of cannabis compared to population controls, both prior and after treatment (Macdonald et al., in review-c). While this study demonstrates an association between cannabis abuse and elevated collision risk, alternative explanations for this relationship cannot yet be ruled out.

Discussion

In this discussion the strengths and limitations of studies are described and conclusions are drawn.

(1) Studies using drug tests

Numerous epidemiological studies have been found where drug tests were conducted of injured drivers. The analytic epidemiological studies that used responsibility analysis or case-control methods have not provided clear proof that cannabis use is related to increased injury risk from collisions. The analytic epidemiological studies have poor statistical power because the presence of drug metabolites is relatively rare and large sample sizes are required to detect significant effects. To demonstrate a relationship exists much larger sample sizes are likely required with methodological approaches free of biases that could inflate odds ratios.

The main strength of studies that use drug tests is that the data are free of the biases found in self-reports. However, the tests are not useful for determining whether those injured were

under the influence of drugs at the time of the injury. Drug test results cannot be used to measure drug impairment, only whether drug use occurred sometime in the past, up to a few weeks for cannabis (Kapur, 1994). Moreover, cannabis has a long half-life and may be detected for several days or weeks after its acute psychoactive effects have ceased (Kapur, 1994). Since the drug tests are detecting those that are not under the influence of cannabis, the measure lacks specificity and therefore very large sample sizes may be needed to find a statistically significant increase in collision rates for those testing positive. Blood tests offer a more promising approach for the assessment of whether drivers are more likely to be under the influence; however, due to their more intrusive nature, they may only be feasible for studies using responsibility analysis of fatally injured drivers. Few studies that use drug tests have control groups, thereby making it difficult to determine whether drug presence is a risk factor. The likely reason few studies include controls is that consent from this group is usually required. Consent is likely to discourage the participation of users more than non-users, which would translate into inflated relative risks or odds ratios. Some studies have used comparison groups of pedestrians; however, this approach is likely too conservative because the pedestrian could also be at fault.

Some studies have noted that different drugs are used in combination with each other, possibly resulting in increased risk for injury. Drug metabolites, for example, are often found in combination with alcohol. Therefore, it is important to separate out the relative role of other drugs from alcohol. Although many studies reported the proportion of collisions that involve alcohol, research has largely failed to separate out the role of alcohol from cannabis in collisions.

The prevalence rates of cannabis positive drivers have varied substantially from study to study and thus, individual studies cannot be deemed conclusive. The variation in findings among studies is likely due to several factors: jurisdictional differences, random error, differing methods

of data collection, and different cut-off points for defining drug presence (Bates and Blakely, 1999).

One comparison of interest is the average percent that tested positive for those in fatal collisions versus those not fatally injured in collisions. In the literature on impaired driving by alcohol, a consistent observation found is that a much higher percent of those in fatal crashes are impaired by alcohol than those in non-fatal crashes. In a review of the literature on injured drivers in the United States, between 40% and 55% of fatally injured drivers have BACs of at least 100 mg% and only 9% to 13% of drivers in collisions had similarly high BACs (Joscelyn, 1978). The percentage of those with high BACs and serious injuries requiring treatment in an Emergency Room is likely higher but not as high as for fatal injuries (Stoduto et al., 1993; Donelson, 1988). Given the very large number of epidemiological studies that have clearly demonstrated a causal link between alcohol impairment and collisions, this observation may have relevance for understanding the importance of cannabis in collisions. The average percent that tested positive for cannabis did not differ substantially between fatal and non-fatal collisions. . For fatal collisions, 10.7% tested positive for cannabis and for non-fatal collisions, 11.5% tested positive. The small differences between the average percentage testing positive for fatal versus non-fatal injuries is inconsistent with observations found in the alcohol literature and may point away from these drugs being major causal agents for injuries due to collisions.

For cannabis, the average percent that tested positive that were suspected of impaired or reckless driving (i.e., special driver populations) was about 35%, which is substantially higher than the injury groups. These findings support the hypothesis that police can identify drivers who are likely to test positive for cannabis but we still do not know what percent were actually intoxicated. The higher percentage could reflect some kind of profiling by police, whether

intentional or unintentional. For example, police might order tests more frequently for lower class, young males, and perhaps those with longer hair or other observations, such as a suggestive clothing or paraphernalia that might indicate a lifestyle that involves cannabis use. Again, since the drug tests can only identify prior use, we do not know if these people were under the influence of cannabis at the time of the crash. Training of police officers in the identification of behavioral symptoms of drug impairment, like that offered in Drug Recognition Expert programs, may offer a promising approach toward identifying drug impaired drivers.

(II) Studies using clinical samples

Few studies exist of collision risk of those in treatment for cannabis abuse, making conclusions tentative. A recent study found cannabis clients have elevated rates collisions compared to population controls. Studies of clinical groups have not provided a good indication of whether the relationships found are causal or merely correlational. Much more research is required to determine whether this relationship is causal. A limitation of practically all studies using survey methods is that associations between drug use and collisions may be spurious. Other factors may be causally related to both drug use and collisions. Recent studies and reviews on set variables, such as aggression (Beirness, 1993; Deffenbacher et al., 2000; Gidron et al., 2001; Wiesenthal et al., 2000), risk-taking/ impulsiveness (Beirness, 1993; Jonah, 1997; Vavrik, 1997), stress (Norris et al., 2000; Simon and Corbett, 1996; Veneziano and Veneziano, 1992), fatigue (Connor et al., 2001; Horstmann et al., 2000; Masa et al., 2000), and criminality (Denison et al., 1997; Wells-Parker et al., 1986) confirm the importance of these characteristics in predicting collisions. Studies have found that many of the characteristics described above are over-represented in substance abuse populations, which might also explain higher collision rates.

Several variables related to drug use are potentially related to injury risk. Frequency of use, severity of substance abuse problems, concurrent use of other drugs or alcohol, and individual reactions to drugs should be investigated. Withdrawal effects from cannabis, such as exhaustion, anxiety, agitation, mood swings and depression and long term effects of abuse, such as chronic sleep disruption, distractibility and depression (Coambs and McAndrews, 1994; Cohen and Sas, 1993; Herscovitch, 1996) also could increase risks.

One of the strengths of studies of clinical samples is the accessibility and validity of information gathered. Although these studies suffer from the same limitations as survey studies of non-clinical samples, the biases related to self-reports are likely much less pronounced in the clinical samples. Since those who seek treatment have already acknowledged that they have a problem, they are more likely to provide accurate accounts regarding that problem. Good validity of self-reports has been established among substance users both during and after treatment (Hindin et al., 1994; Nelson et al., 1998).

Table 7a: Summary of study results on the percent of injury testing positive for cannabis

Authors	Jurisdiction	Consent required	% positive cannabis	Comparison Group	Study Group	Comments
Brookoff et al., 1994	Memphis, Tennessee, U.S.A.	No	33%	No	150 drivers stopped for reckless driving	12% positive for both cocaine & cannabis. 18.7% positive for alcohol (.03-.21 mg/dL.).
Budd et al., 1989	Los Angeles, California, U.S.A.	No	19.6% (Prelim.) 18.5% (Follow-up)	No	Preliminary study: 102 fatally injured drivers Follow-up study: 492 fatally injured drivers	18.6% positive for alcohol + cocaine/cannabis/both (Prelim). 16.2% positive for alcohol + cocaine/cannabis/both (Follow-up).
Christopherson et al., 1990	Norway	No	31.5%	No	3159 drivers suspected of driving under the influence of alcohol & drugs	1 or more drugs present in 67%.
Cimbura et al., 1990	Ontario, Canada	No	10.9% - drivers 7.6% - pedestrians	No	1169 fatally injured drivers, 225 fatally injured pedestrians (aged 14 or older)	9.2% positive for cannabis + alcohol (drivers). 5.8% positive for cannabis + alcohol (pedestrians).
Crouch et al., 1993	Salt Lake City, Utah, U.S.A.	No	13%	No	168 fatally injured truck drivers	Impairment due to cannabis use in all cases where THC level exceeded 1.0 ng/mL. 2.3% positive cannabis + alcohol 20% of accidents positive for drugs had driver fatigue.
Dussault et al., 2002	Quebec, Canada	No for fatal drivers, yes for controls	19.5% for fatal drivers 6.7% for controls	Yes	354 fatally injured drivers 11,952 roadside controls	Fatalities were significantly associated with positive tests for cannabis in the case-control study. No significant relationship was found for the responsibility analysis. Selection bias due to the 49.6% response rate of providing a urine sample for the control group could have inflated the odds ratios.
del Rio & Alvarez, 2000	Northern Spain	No	1.4%	No	285 fatally injured drivers	Of all positive for drugs, 19.6% were also positive for alcohol.
Drummer, 1995	Melborne, Australia	No	11%	Yes drivers not responsible	1045 fatally injured drivers. 1990-1993	Responsibility analysis conducted. ns for cannabis

Authors	Jurisdiction	Consent required	% positive cannabis	Comparison Group	Study Group	Comments
Everest & Tunbridge 1989	England and Wales	No	2.6%	No	1273 fatalities (drivers, passengers, motorcycle drivers, pedestrians)	8.3% of those positive for drugs were also positive for alcohol (>.08mg.100mL).
Fortenberry et al., 1986	Alabama, U.S.A.	No	11% - drivers 5% - passengers 1% - pedestrians	No	510 fatally injured drivers, passengers, and pedestrians with urine samples	8.8% positive for both cannabis + alcohol
Kintz et al., 2000	Strasbourg, France	No	9.6%	No	198 injured drivers (car, motorcycle, truck, bicycle) aged 13-57	
Logan & Schwilke, 1996	Washington State, U.S.A.	No	11%	No	347 fatally injured drivers	10% positive for alcohol + drugs; 15% positive for drugs alone; 63% of cannabis users positive for alcohol.
Longo et al., 2000a,b	Australia	No	10.8%	Yes non-culpable drivers	2500 injured drivers admitted to an ER	7.1% tested positive for cannabis only Blood tests taken, most drivers who tested positive for THC –acid, the inactive metabolite
Marquet et al., 1998	France	No	Drivers - 13.9% Patients -7.6%	Yes 278 non-injured patients aged 18-35	296 injured drivers aged 18-35	Prevalence of cannabis among female drivers was significantly higher than for female patients ($p<.05$)
Mason & McBay, 1984	North Carolina, U.S.A.	No	7.8%	No	600 fatally injured drivers	11% positive for alcohol + drugs; 2.8% positive for drugs alone.
McBay, 1986	Los Angeles, California, U.S.A.	No	13.4%	No	2610 fatally injured drivers	2.8% of drivers were positive for cannabis without any other drug; 28% positive for drugs + alcohol.
McLean et al., 1987	Tasmania, Australia	No	6% of total sample	Yes 387 blood donors	194 road users (42 fatally injured, 37 accident survivors, 115 breath tested drivers/ riders)	8% of those positive for alcohol (>.5g/L) had also used cannabis. Ns differences in drug use between groups.

Authors	Jurisdiction	Consent required	% positive cannabis	Comparison Group	Study Group	Comments
Mercer & Jeffery, 1995	British Columbia, Canada	No	13%	No	227 fatally injured drivers	11% positive for alcohol & drugs
Orsay et al., 1994	Chicago, Illinois, U.S.A.	No	7.4% of total sample	Yes 300 non-impaired, injured drivers	285 alcohol or drug-impaired, injured motorists & motorcyclists	Impaired drivers had higher Injury Severity Scores than control drivers ($p<.001$). Impaired drivers more frequently involved in collisions, cited for moving violations; found to be at fault.
Peel & Jeffrey, 1990	Canada	No	20% of impaired drivers	No	492 cases: 94 injured; 172 impaired and 226 fatally injured drivers	Of 53 impaired drivers, 4% positive for cannabis
Poklis et al., 1987	St. Louis, Missouri, U.S.A.	No	47%	No	137 drug positive DUI drivers Jan. 1983 to May 1986	32 different drugs detected.
Risser et al., 1998	Vienna, Austria	Yes	47% of 19 samples in 1993; 72% of 99 samples in 1996	No	205 reckless drivers from 1993-1996. Aged 17 to 24 years. 199 car drivers; 6 motorcycle drivers	Increase in cannabis use increased significantly over time ($p<.05$).
Seymour & Oliver, 1999	Strathclyde, Scotland	No	39% of impaired drivers	Yes 151 fatally injured drivers	752 drivers suspected of being impaired	Drugs were present in 19% of fatally injured drivers; polydrug use was prevalent; alcohol detected in 33%.
Soderstrom et al., 1995	Baltimore, Maryland, U.S.A.	No	12%	No	1338 injured (1077 car drivers; 261 motorcyclists)	
Stoduto et al., 1993	Toronto, Ontario, Canada	No	13.9%	No	339 injured drivers admitted to trauma unit (291 car drivers; 48 motorcyclists)	16.5% positive for alcohol & drugs.

Authors	Jurisdiction	Consent required	% positive cannabis	Comparison Group	Study Group	Comments
Sugrue et al., 1995	Sydney, Australia	No	15.2% drivers (>100ng/dL);8% cyclists (>200ng/dL)13%; passengers (>200ng/dL) 14%; pedestrians (>200ng/dL)	No	Total 262 (164 injured drivers, 12 pedal cyclists, 31 pedestrians, and 55 passengers). 16% positive alcohol & drugs.	
Terhune & Fell, 1982	Washington, D.C., U.S.A.	No	10%	No	500 injured drivers	25% positive for alcohol.
Williams et al., 1985	California, U.S.A.	No	37%	No	440 fatally injured male drivers aged 15-34	Percentage of crash responsibility increased significantly from 0 drugs to 2 or more detected drugs (p>.001); 81% of cannabis users positive alcohol.

Table 7b: Studies of self-reported drug use and injuries in clinical samples

Authors	Jurisdiction	Comparison Group	Research Objective	Study Group	Comments
Albery et al., 1999	London, England	No	Examine collision rates among 210 out-of-treatment drug users	210 out of treatment drug users.	62.1% of cannabis users drove at least once after using the drug; frequency of driving after using drugs was not significantly related to collisions.
Macdonald et al., in review-c	Toronto, Canada	Yes	What is the collision risk of cannabis abuse clients in treatment compared to population controls	Treatment clients with a primary drug problem of cannabis, Matched population controls	The cannabis clients had significantly more collisions before and after treatment
Mann et al., 1993	Toronto, Canada	No	Examine the contribution of drug use to accident rates	144 male substance users aged 21-40	50% of the accidents that occurred in the past 5 years occurred under the influence or alcohol and/or drugs
Mann et al., 1995	Toronto, Canada	Yes	Evaluated the effects of substance abuse treatment on accident rates	137 males, aged 21-40 who were in treatment for substance use.	There were significant declines in number of accidents ($p<.05$), drinking-driving convictions ($p<.001$), and moving violations ($p<.001$) after treatment.
Smart et al., 1969	Toronto, Canada	Yes	Investigate accident rates of abusers of one or more drugs other than alcohol	30 psychiatric patients	Patients had an overall accident rate 1.9 times larger than the expected rates

6. *Pharmacology of Cannabis and Assessing its Presence in Drivers*

Brands et al (1998) provide an extensive discussion of the pharmacology of cannabis, and this discussion is based on the information provided there. *Cannabis sativa* is the botanical name for the Indian hemp plant from which marijuana, hashish and hashish oil are prepared. More than 60 constituents known as cannabinoids occur naturally in the plant but the main psychoactive cannabinoid is delta-9-tetrahydrocannabinol (Δ^9–THC). The female plant secretes a sticky resin which covers the flowering tops and upper leaves. Marihuana is prepared from the flowering tops and leaves of the plant and the THC content varies according to the climate, growing conditions etc. Hashish is the dried cannabis resin and compressed flowers and hashish oil is a potent oil extracted from hashish. The concentration of THC in marijuana can range from as little as 1% to 10% or more while the hashish and hashish oil can range up to 20 and 70% respectively.

The most common route of administration is by smoking a hand rolled 'joint' but both marihuana and hash are frequently smoked through a pipe. Hash oil is used sparingly (due to its high potency)- usually a drop is placed on a joint. Cannabis, particularly hashish, may also be cooked or baked in foods.

Effects in Humans

1. Short-Term Use: Low to Moderate Doses (5mg of THC, non-tolerant user)
   - ❑ Central Nervous System (behavioural, subjective)
     - ♦ disinhibition, talkativeness, relaxation, drowsiness
     - ♦ general feeling of well-being (exhilaration, euphoria)

- ♦ perceptual distortions of time, distance
- ♦ enhanced sense of touch, smell, taste
- ♦ spontaneous laughter
- ♦ mild impairment of short-term memory
- ♦ reduced attention span
- ♦ impaired ability to perform complex motor tasks

❑ Cardiovascular

- ♦ increased heart rate
- ♦ increased peripheral blood flow
- ♦ rapid fall in blood pressure
- ♦ reddening of the eyes

❑ Respiratory

- ♦ irritation of mucous membranes lining the respiratory system
- ♦ bronchodilation

❑ Gastrointestinal

- ♦ increased appetite
- ♦ dryness of mouth and throat

2. Effects of Short-Term Use: Higher Doses (10-20mg of THC, non-tolerant users)

❑ Intensification of the effects above plus any of the following:

❑ CNS (behavioural, subjective)

- ♦ synesthesias (e.g., when a sound produces a sensation of colour)

- ♦ pseudohallucinations
- ♦ impaired judgment
- ♦ slowed reaction time
- ♦ impaired performance of simple motor tasks
- ♦ acute toxic psychosis (very high doses)

3. Effects of Long-Term Use
   - ❑ Impairments of short-term memory, concentration and abstract thinking
   - ❑ Respiratory effects

Tolerance and Dependence

Tolerance to the desired effects of cannabis develops with chronic, heavy use. With very regular high-dose use tolerance also develops to other effects such as rapid heart beat and impairment of performance on psychomotor and cognitive tasks.

Psychological dependence may develop with regular use. Physical dependence may also develop in those who use high doses of cannabis. Abrupt cessation of use can produce a mild withdrawal syndrome characterized by insomnia, anxiety, irritability, loss of appetite. These symptoms usually last for less than a week.

Pharmacokinetics

The pharmacokinetics and pharmacodynamics of cannabis have been extensively reviewed (Martin and Cone, 1999, Grotenhermen, 2003, Ashton, 2001). THC is rapidly absorbed following inhalation. It is detectable in the bloodstream almost immediately and peaks within 10 minutes after starting to smoke. The bioavailability of THC after smoking ranges from

10 to 35% and depends on the experience of the user (e.g., it varies based on the depth and spacing of inhalations and the hold time). Absorption after the oral route is more erratic and gradual, peaking after 1 to 6 hours. The bioavailability is lower orally (6 to 14%) due to breakdown in the gut and liver prior to reaching the systemic circulation.

After absorption, THC and other cannabinoids are widely distributed to all other tissues with the rate depending on blood flow. THC rapidly moves in and out of many tissues, including the brain, however cannabinoids are extremely lipophilic and for this reason their distribution pattern changes over time as they accumulate in fatty tissues. They are then slowly released back into other body compartments.

THC is primarily and extensively metabolized in the liver. The major metabolite is 11-OH-THC which is further broken down to THC-COOH. The first metabolite, 11-OH-THC, has activity similar to THC and crosses into the brain more easily, although it is found in higher concentrations only after oral administration. THC is excreted in the urine (20-35%) and faeces (65-80%) mainly as metabolites. THC-COOH, is the most abundant metabolite found in urine and plasma. Metabolites can be found in the urine for up to 12 days after a single dose of THC and for a month or two after heavy use.

Pharmacodynamics (as related to Pharmacokinetics)

Cannabinoids exert their effects by interacting with specific receptors CB_1 and CB_2 (Devane et al., 1988; Munro et al., 1993) that are distributed predominantly in the central nervous system and immune systems respectively. Pharmacological 'high' effects are produced rapidly and generally peak within 30 minutes from the start of smoking and taper off within 3-4

hours. After oral use, psychotropic effects peak between 2 and 4 hours after use, and decline substantially by 6 hours (Grotenhermen, 2003).

Among the effects of cannabis on the human body are effects on cognition and psychomotor performance. Generally, the behavioural and physiological effects of cannabis subside within 4-6 hours; however, impairment of skills related to driving has been demonstrated up to 24 hours after smoking cannabis (Martin and Cone, 1999). Since the blood levels of THC peak prior to drug-induced effects it was thought that a meaningful relationship between drug levels and effect did not exist (Mason and McBay, 1985; McBay, 1986). Since that time a better understanding of the distribution of lipophilic substances such as THC has emerged (Martin and Cone, 1999) and pharmacokinetic/pharmacodynamic models have been developed to relate levels of THC in blood to physiological, behavioural and performance changes produced by cannabis. Several models have also been developed to predict time of cannabis smoking from plasma levels of cannabinoids (Cone and Huestis, 1993; Huestis et al., 1992).

Analytical Testing Methods

A variety of analytical techniques have been used to detect and measure THC and metabolites in biological fluids. Often, initial detection methods are based on thin layer chromatography (TLC) and immunoassay such as radioimmunoassay (RIA), enzyme immunoassay (EIA), fluorescence polarization immunoassay (FPIA), and kinetic interaction of microparticles in solution (KIMS). Most commercial immunoassays have been developed to detect 11-*nor*-9-carboxy-THC in urine at cutoff levels of 20, 50, or 100ηg/mL. One limitation of this methodology is that the antibodies display varying degrees of cross-reactivity to other cannabinoids. Other analytical techniques with greater specificity include high-performance

liquid chromatography (HPLC) and gas chromatography/mass spectrometry (GC/MS) (Martin and Cone, 1999). HPLC with amperometric detection has been used to measure THC in blood and saliva (Thompson and Cone, 1987). HPLC with electrochemical detection has also been used to measure 11-*nor*-9-carboxy-THC in urine and plasma (Nakahara et al., 1989). GC/MS has been used to measure several cannabinoids in biological fluids with excellent sensitivity and specificity (Foltz et al., 1983).

Comparison of Measures to Detect Cannabis in Drivers

Several means to detect the presence of cannabis in drivers have been proposed. These methods will be briefly described here.

Breath Tests.

The availability of accurate and simple-to-use breath tests for alcohol have been central to current efforts to reduce drunk driving (Mann et al., 2001). There has been a continued interest in the development of a breath test for cannabis over the years, but to date no scientifically validated tests have been reported (Verstraete, 2000).

Blood Tests.

Blood tests are the 'gold standard' for assessing levels of cannabis and metabolites in the body. Results of blood tests can be influenced by such factors as the temperature at which the sample is stored and binding to the inner surface of plastic vials (O'Kane et al., 2002). The logistic and legal issues involved in obtaining and testing blood samples from drivers suspected of DUIC are complex. Currently, Canadian legislation allows police to request a blood sample

from a driver, but this is very rarely done. As noted earlier, the mere presence of cannabis in plasma may not indicate impairment. A current focus of research is to identify a relationship between THC in blood (and other body fluids) and behavioural change, drug influence and impairment (Martin and Cone, 1999). This has lead to the suggestion that per se levels of cannabinoids in plasma may be indentified for legal purposes, similar to the identification of per se levels for alcohol (Martin and Cone, 1999).

Urine Tests.

Urine tests are used in situations where any relatively recent use of cannabis and other drugs is of interest (e.g., in sports, in addictions treatment), regardless of whether that use occurred in the previous few hours, days, or even weeks. However, urine tests do not permit an accurate assessment of when drug use occurred (Kapur, 1994). Thus a driver who has a positive urine test for cannabis may have used the drug in the preceding hours or days (or even weeks), and thus his or her driving skills may not be influenced by the drug at the time the sample is taken.

Saliva and Sweat Tests.

The detection of cannabinoids in saliva and sweat has been an active area of research. Current kits to measure saliva involve taking a swab from the mouth and include a rapid detection kit (O'Kane et al., 2002). Available data suggest that saliva THC levels arise from drug that has remained in the mouth during smoking or ingestion, and initial data suggest that these levels are associated with degree of impairment observed (Menkes et al., 1991).

Assessing Behavioural Effects of Cannabis

There has been substantial recent interest in programs involving the training of police officers and others to detect the physiological and behavioural effects of cannabis in individuals suspected of DUIC, and research on this topic is beginning to appear. Drug recognition expert (DRE) programs have been developed to enable police officers to identify an individual who may be under the influence of a drug. These indicators can range from pupil size and body sway to the presence of drug paraphernalia in the vehicle. Walsh and Cangianelli (2002) reported that, in drivers suspected of Driving Under the Influence of Drugs(DUID) by DRE-trained police officers, subsequent blood testing revealed that 32.5% were positive for at least one drug other than alcohol. This low level of sensitivity improved to 79.3% when officers were subsequently given an improved training program. Tzambazis and Stough (2003) presented evidence that cannabis-induced impairment of performance on behavioural tests (Standardized Field Sobriety Tests) was significantly correlated with impairment of driving.

7. Legislative Approaches to Drugs and Driving in Various Jurisdictions

Although the extent of collision risk posed by DUIC is not yet clear, many or most jurisdictions have legal measures that can be applied, in principle, to individuals who drive after using cannabis. These measures are described here.

Canada

Under the Criminal Code of Canada, section 253(a) governs driving while impaired by alcohol and drugs (the full set of codes is presented in Appendix A):

253. Every one commits an offence who operates a motor vehicle or vessel or operates or assists in the operation of an aircraft or of railway equipment or has the care or control of a motor vehicle, vessel, aircraft or railway equipment, whether it is in motion or not,

(a) while the person's ability to operate the vehicle, vessel, aircraft or railway equipment is impaired by alcohol or a drug

Driver impairment is a reduced ability to operate a vehicle when compared to the normal driver. Many sections that follow 253(a) of the Criminal Code of Canada deal with issues relating to evidence and procedure for an alcohol and driving charge. Two Criminal Code sections deal with gathering drug-impaired driving evidence. Subsection 258(5) of the Criminal Code states that where a blood sample is taken to test for the presence of alcohol, it may be further tested for the presence of a drug. Also, in 2001, Parliament amended section 256 to add drugs as a basis to obtain a warrant to have a medical practitioner take blood from an

unconscious driver who is reasonably believed to have been committing a section 253 offence and to have been involved in a collision resulting in death or injury.

There is no per se drug offence (the per se alcohol offence is in section 253(b)). The police must gather evidence by observation of erratic driving and/or observing the driver for signs of impairment. The prosecution must prove that impairment was caused by a drug other than alcohol and not some other condition.

A jurisdictional survey on driving while impaired by drugs (CCMTA, 2002), available on the CCMTA website (www.ccmta.ca), reports that British Columbia has trained 200 police officers as Drug Recognition Experts (DRE). DREs are uncommon in other provinces; however, some are planning a DRE program in future while others are monitoring how the BC courts deal with these DRE cases before they consider introducing a similar program. Also, the officer training in The Standardized Field Sobriety Tests (walk-and-turn, one-leg stand, horizontal gaze nystagmus) seems to vary across provinces.

European Union

The ROSITA report (Moeller, Steinmeyer and Aberl, 1999) provides results of a survey conducted of European Union countries' legislation regarding drugs and driving.

All European Union countries have legal provisions on DUID. If impaired driving is due to substance abuse one can be sanctioned, but impairment has to be proven in court. Therefore, the legislative approach is difficult to enforce due to the difficulty in documenting impairment objectively. Some countries have tried to get around this by using legislation solely based on the detection of drugs in the blood. Germany introduced a law in 1998 and Belgium in 1999 and others are proposing similar laws to be implemented in the near future. The majority of countries

still have the former type of legislation in place. Table 8 presents the various legislative approaches of European Union countries.

Legislation which allows for sanctions based on detection of drugs alone depends on the police forces' capability to obtain the appropriate specimens; therefore, the police's authority to collect human specimens at the roadside for testing or for confirmatory analysis is of utmost importance. This authority is regulated by other

Table 89: Legislative approaches for drugged-driving: European Union countries.

Country	DUID Legislation	Impairment or analytical approach?	Roadside testing for DUID allowed	Initial suspicion for roadside drug test needed	Roadside drug test devices in routine use
Austria	yes	Impairment	yes	yes	no
Belgium	yes	Analytical/Impairment	yes	yes	yes
Czech Republic	yes	Impairment	yes	yes	no
Denmark	yes	Impairment	no	no	no
Finland	yes	Impairment/Analytical	yes	yes	no
France	yes	Impairment	no	-	no
Germany	yes	Analytical/Impairment	yes	yes	yes
Greece	yes	Analytical/Impairment	yes	no	no
Iceland	yes	Impairment	yes	no	no
Ireland	yes	Impairment	yes	yes	no
Italy	yes	Impairment	yes	yes	no
Luxembourg	yes	Impairment/Analytical	yes	no	no
Netherlands	yes	Impairment/Analytical	no	-	no
Norway	yes	Impairment	yes	yes	no
Poland	yes	Impairment	yes	yes	no
Slovenia	yes	Impairment	yes	yes	no
Spain	yes	Impairment	yes	yes	no
Switzerland	yes	Impairment	yes	yes	no
Unit. Kingdom	yes	Impairment	no	yes	no

Source: Moeller, Steinmeyer, Aberl, 1999.

legislation that differs by jurisdiction. Some countries allow the police to control and test the public randomly and suspicion is not necessary for testing. The majority of countries treat roadside testing as an infringement of civil rights and suspicion is necessary for testing.

In Appendix B, Table A1 (divided in 5 parts) presents an overview of DUID legislation in the 19 countries, including the exact laws, named drugs, limits and exemptions, and if amendments of the legislation are planned in the near future. Table A2 provides detailed information on countries in which amendments of the legislation are planned in the near future.

Some states have improved the process for initial suspicion by introducing training programs for police to identify intoxicated drivers on the basis of physical and psychomotor signs. Germany and Belgium are the only countries so far using roadside testing devices routinely; sweat and urine are the specimens being collected. Some countries have used urine or saliva or sweat test devices on an experimental basis with the driver's consent. Very few European countries have regulations prohibiting the use of roadside drug testing devices. Most do not use these devices because of their concerns about their validity or their unavailability.

The classes of drugs where detection is deemed most important are cannabis, benzodiazepines, amphetamines, cocaine and opiates in decreasing order of frequency. The preferred test is a single use, multi-parameter test, which is able to provide a clear, unambiguous test result within 5 minutes. According to Moeller et al. (1999), saliva is the preferred test specimen for cannabis due to its easy availability, low invasiveness and good correlation with impairment (Moeller et al., 1999). Sweat was the second in preference because it allows testing without collaboration of the driver, and its low invasiveness and good availability at the roadside.

United States

Walsh and colleagues (2002) describe the drugged driving laws for the United States as of December 2000. In the United States, DUID statutes are mainly found in the Transportation or Motor Vehicle Codes or Titles of states' Codes or Statutes. Three states, Idaho, Minnesota and Texas contain DUID statutes in the Penal Code or Criminal Title. Other than Texas and New York the phrase 'under the influence' is used in the DUID statute. Several states define the standard that constitutes 'under the influence' within the statute. Fourteen states (Alabama, Arkansas, Illinois, Kansas, Nevada, Maryland, New Mexico, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont, Wisconsin, and Wyoming) set the standard at 'incapacity', in that the drug 'renders the driver incapable of safely driving.' These states have defined the standard in the DUID statute. Incapacity to drive safely is linked to the drug ingested and the prosecutor must show a connection between the drug use and incapacity of the driver.

Eight states (Arizona, Florida, Hawaii, Indiana, Kentucky, Montana, South Carolina, and Virginia) define 'under the influence' as meaning that the driver's ability is impaired. Despite the less stringent requirements for an effect on the driver, the prosecutor still must prove that impairment is directly related to the drug use. Six states (Colorado, Michigan, Minnesota, Mississippi, Oklahoma, and Tennessee) use the impairment standard to construct a separate offense so that the person can be charged with either driving under the influence or impaired driving or both. New York also uses the term 'impaired driving' but doesn't have the offense 'driving under the influence.' Texas uses the standard of intoxication which is defined as 'not having the normal use of mental or physical faculties' by reason of drug use.

Texas also makes it illegal for a person with an addiction to a controlled substance or another drug which renders the person incapable of driving, to receive a driver's license. There

are 16 states in total that have variations of zero tolerance type legislation with regard to DUID. Five states (California, Colorado, Idaho, Kansas and West Virginia) make it illegal for a drug addict or habitual user of drugs to drive in their states. In two states (North Carolina, South Dakota) it is illegal for those under 21 years of age to drive with any amount of a prohibited drug or substance in their body.

Nevada has per se laws which specify the percentage of prohibited drugs or substances other than alcohol that make it illegal to drive. There are only eight states (Arizona, Georgia, Indiana, Illinois, Iowa, Minnesota, Rhode Island, and Utah) where it is illegal to drive with any amount of a prohibited drug or substance in the body. In these states, any amount of drug found in the urine or blood of a driver while operating a vehicle is a per se violation of the statute. Washington also has a 'negligent driving' statute that prohibits driving if it 'endangers or is likely to endanger any person or property, and [the driver] exhibits the effects of having consumed an illegal drug.'

Only Washington and New York have DUID statutes that are separate from their DUI-alcohol statutes. All the other states have one statute that covers driving under the influence of alcohol, drugs, or a combination of alcohol and drugs. Most of these states have the same penalty for drug or alcohol. Only Washington has different penalties for drug versus alcohol in their DUI statute.

Australia

A report produced by the Queensland Parliamentary Travelsafe Committee (1999) presents details regarding Australian states' drugs and driving legislation. All Australian states have provisions that make it an offense to drive while under the influence of alcohol or a drug,

although the wording varies. Victoria is undergoing a major revision of drugged driving legislation and operating procedures and New South Wales has had a successful system in place for about a decade.

Victoria's DUID legislation is that of driving "while under the influence of intoxicating liquor or of any drug to such an extent as to be incapable of having proper control of the motor vehicle," (Queensland Parliamentary Travelsafe Committee, 1999). Evidential requirements to sustain a charge are quite onerous: "It is not sufficient to establish that the drug was present and that the drug had an effect on the person's ability to drive. The prosecution must go further. It must establish impairment by a drug and the level of impairment prevents proper control of a motor vehicle," (Queensland Parliamentary Travelsafe Committee, 1999). Also, the police do not have the authority to require blood or urine samples from drivers suspected of impairment and no standard procedure or test exists to determine if the person is physically or mentally impaired. Many proposed changes include: replacing the offence to "driving while impaired", adopting a generic definition of 'drug', giving police specific power to require drivers suspected of being impaired to undergo a roadside test of impairment and, if necessary, a more detailed test, and allowing blood and or urine samples to be taken and analysed for drugs where a driver has failed a second impairment test.

The New South Wales legislation was changed in 1987 to allow police to obtain a blood and urine sample from drivers/riders they suspected of being affected by a drug and certain procedures are followed before a driver is submitted to drug testing. Drugs are defined as alcohol and drugs listed under different Acts. With non-injured accident involved drivers or where they witness a person driving erratically the police must obtain evidence of impaired behaviour. If a breath test indicates the driver is below the legal limit and the police suspect the driver is under

the influence of a drug they are authorized to require an assessment of the driver's sobriety and if the police believe the driver is under the influence of a drug the driver can be arrested and taken to a hospital to provide blood and urine samples. In Western Australia the legislation states that "a person who drives or attempts to drive a motor vehicle while under the influence of alcohol, drugs, or alcohol and drugs to such an extent as to be incapable of having proper control of the vehicle commits an offence, and the offender may be arrested without warrant," (Queensland Parliamentary Travelsafe Committee, 1999). Police have the power to require the driver to undergo a preliminary test for alcohol and if the result is under the legal limit and they suspect drug impairment they can take the driver to a police station or another place for further testing. Then the driver is given a breath test. If it provides results of no alcohol in the blood or the percentage of alcohol in the blood is such that it doesn't reasonably explain the conduct, condition or appearance of the person they may require a blood or urine test or both. A medical practitioner is called to conduct the medical examination and take the samples.

DUID in South Australia is dealt with by legislation that a person must not drive a motor vehicle "whilst so much under the influence of intoxicating liquor or a drug so as to be incapable of exercising effective control of the vehicle," (Queensland Parliamentary Travelsafe Committee, 1999). Where a driver is breath tested by police and the result is inconsistent with the driver's behaviour and the police suspect the driver is under the influence, they can charge the driver. Following arrest the police ask the driver questions about the driver's actions before the arrest, such as whether they had taken drugs or alcohol, and make observations of the driver's breath, attitude, eyes, walk, stance and speech. The driver can then be required to undergo a medical examination and a blood sample can be taken for analysis for drugs.

In Queensland, to sustain a charge of driving under the influence of drugs it is necessary for the prosecution to be able to prove: impairment to the person's normal state, the presence of alcohol and/or a drug, and a connection between the person's impairment and the level of alcohol or drug present. The police do have the power to require a blood or urine sample for laboratory analysis, provided he/she believes on reasonable grounds that the driver showed external signs indicating the driver was affected by liquor or a drug. The officer also must have conducted a breath analysis that indicated no alcohol was present or did not reasonably explain the external signs exhibited or observed. The police do not have the power to detain people to conduct impairment tests.

8. Conclusions

The question of what impact cannabis has on traffic safety in Canada is an important one from many perspectives. There is substantial public and political interest in the issue that is likely to continue in the foreseeable future. As has become clear in this review, there is a substantial amount of information available that can shed light on this issue, but there are as well many areas in which available evidence is sparse or unclear.

First, it appears clear that, in a laboratory situation, cannabis impairs the skills thought to be necessary for safe driving. This impairment is not restricted to high levels of the drug, and occurs at the dosage levels that result from typical use of the drug. Tolerance may occur with continued use, but even individuals who have acquired tolerance to some of the effects of cannabis may demonstrate impairment on task performance. Combining alcohol with cannabis will result in an increase in the effects of cannabis, and the interaction could be multiplicative.

Cannabis use in Canada appears to have been rare before the 1960s, but in that decade increased substantially. At the beginning of the 1970s one study indicated that nearly half of young adults had used cannabis. More recent data suggest that, among adults, a minority report cannabis use in the past 12 months. This proportion was lowest in Ontario at 4.9%, and highest in British Columbia at 11.4%. However, these estimates are more than 10 years old and thus may have changed over time. Cannabis use is more common among males than females, and declines with age. In Ontario, data are available to examine trends in cannabis use since the late 1970s. Among students in secondary schools, the proportion who reported cannabis use declined from a peak of 31.7% in 1979 to a low of 11.7% in 1991. However, the proportion of users has been increasing since then, and in the most recent survey reached 28.6%, near the peak usage levels seen in 1979. Among adults no clear trends over time are observed, with the proportion reporting

use of cannabis in the past 12 months ranging from 6.2 and 11.2% over the years. Most recently (in 2000), it was observed to be 10.8%.

DUIC appears to be relatively uncommon in the general population, with less than 2% of drivers reporting this behaviour in the past 12 months. However, among certain subgroups, it is much more common. DUIC is reported by between ¼ and ⅓ of cannabis users. It is also more likely among males and younger drivers, and one recent study found that the proportion of drivers in Ontario high schools who reported DUIC was higher than the proportion who reported driving after drinking.

After alcohol, cannabis is the drug most often found in dead and injured drivers. In Canadian samples, cannabis has been found in 10.9% to 19.5% of dead drivers, and one study found that 13.9% of crashed drivers admitted to a trauma unit were positive for cannabis. However, this evidence does not necessarily mean that cannabis was a causative factor in those collisions. For example, a general population sample may reveal similar proportions testing positive for cannabis. Epidemiological studies employing control groups are necessary to identify more precisely the contribution of the drug to collision causation. Case-control studies, in which samples of injured or killed drivers are compared to control samples, do not yet provide conclusive evidence that cannabis contributes to collision risk. This is primarily because of the difficulties involved in obtaining an appropriate control group for these studies. While the small numbers of existing studies provide some indications of increased risk, methodological concerns preclude firm conclusions. Studies employing clinical samples provide an additional means for assessing collision risk among cannabis users, and some indications of increase in risk are appearing in these studies as well. Again, though, increased collision risk in these studies may be due to factors other than the effects of cannabis.

Central to the problems of assessing the impact of cannabis on collision risk and to the problem of detecting cannabis-impaired drivers is the problem of measuring the presence of cannabis in the body. Understanding of the impact of alcohol on collision risk and the development of appropriate legal and other initiatives have been greatly facilitated by the development of reliable and easily-employed technologies to measure the presence of alcohol in the body, and to relate those levels to the behavioural effects of alcohol. The measurement of cannabis in the body is much more difficult, and this has hampered research on the effects of cannabis and the potential development of legal initiatives to address cannabis-impaired driving. However, there are indicators that important advances have been made or can be expected in this area. Research is now beginning to address issues of dose-response effects on skills and behaviour. As well, some new measures that may assist in the detection of DUIC (saliva tests, DRE programs, Standardized Field Sobriety Tests) show promising results in field trials.

Canada's laws allow for the laying of charges for driving while impaired by cannabis, through section 253(a) of the Criminal Code. Most other Western nations have legal provisions that permit laying charges for DUIC. However, most of these are similar to Canada's, in that they involve a generic offense of impaired driving. Some jurisdictions have enacted, or are considering, specific laws to prohibit DUIC or DUID. In some American states per se laws, similar to alcohol per se laws, are in place and in other jurisdictions driving with any level of cannabis or other drugs in the body is an offense.

Directions for future research

Our ability to assess and respond to the issue of DUIC is only as good as the information available on the issue. This review has identified a substantial amount of available information, but it has also identified many gaps in our knowledge.

Assessment of the effects of cannabis on performance of laboratory tasks has added much to our understanding of the effects of this drug. The effects of cannabis have been investigated on a wide variety of tasks. One very useful addition to the literature would be further information on the extent to which the effects of cannabis are dose-related.

Available survey data provide a valuable picture of the use of cannabis in the general population of Canada. However, with the exception of Ontario, much of the data is several years old and could usefully be updated. As well, the value of repeated surveys, in permitting an understanding of trends in use over time, cannot be overstated. Similarly, much more information on the prevalence of DUIC would be very valuable. These surveys can also serve the useful purpose of identifying regional differences in DUIC and potential risk factors for the behaviour.

Analytic epidemiological studies, with designs similar to the one conducted by Marquet et al. (1998), are useful for understanding relative risks; however, future studies of this kind should include much larger sample sizes. One impediment to conducting such studies is that use of drug tests without consent may not be ethically acceptable in some jurisdictions. Some hospitals justify tests without consent if they are considered useful for health related diagnostic purposes (Stoduto et al., 1993) and this approach may be fruitful in future studies. Another useful approach that is less ethically restrictive was utilized by Longo et al. (2000b) where the proportion responsible for their crash or injury who test positive are compared to the same

proportion who are not responsible. This approach is especially feasible for fatalities but again large sample sizes are required. Another improvement of future studies that use drug tests is to incorporate self-reported information on drug use and other risk factors for injuries. This approach could be particularly useful for assessing the validity of self-reports; however, if consent is required the utility will be limited.

Another area of research that has received scant attention is understanding the impacts on collision risk of chronic heavy use of cannabis, including that of medical patients who would also have other complicating medical conditions. Further understanding of how drugs interact with one another and whether their combination of use produces synergistic effects in terms of injury risk is needed.

Future survey research of both general and clinical populations should continue to address issues of causality between cannabis use and collisions. We need to know whether cannabis impairment exists when collisions occur. Additionally, other variables need to be ruled out that might better explain collision risk. Variables that should be addressed in future research include personality characteristics, risk-taking, aggression, criminality, and stressful life events, in order to control for their potential confounding influence on the relationship between use of cannabis and risk of collisions.

Further work to develop and validate measures to detect DUIC would also be very valuable. Currently, available means for detecting cannabis-impaired drivers are either impractical, time consuming, or only at the stage of preliminary evaluation. While new technologies and procedures for detecting DUIC are available, research to assess the value and utility of these measures in a Canadian context is clearly necessary.

9. References

Adams, I.B., Martin, B.R. 1996. Cannabis: pharmacology and toxicology in animals and humans. Addiction, 91(11), 1585-1614.

Adlaf, E.M., Ialomiteanu, A. 2001. CAMH Monitor eReport: Addiction and Mental Health Indicators Among Ontario Adults, 1977-2000. Toronto: Centre for Addiction and Mental Health. www.camh.net/research/population_life_course.html#200report.

Adlaf, E., Ivis, R., Smart, R.G. 1994. Alcohol and other drug use among Ontario adults in 1994 and changes since 1977. Toronto: Addiction Research Foundation.

Adlaf, E.M., Mann, R.E., Paglia, A. 2003. Drinking, cannabis use and driving among Ontario students. Canadian Medical Association Journal, 168(5), 565-566.

Adlaf, E.M., Paglia, A. 2001. Drug Use Among Ontario Students: Findings from the OSDUS. Toronto: Centre for Addiction and Mental Health.

Adlaf, E.M., Paglia, A. and Mann, R.E. 2003. Cannabis use and driving among Ontario adults. CAMH Population Studies eBulletin, May/June 2003, No. 20. Toronto: Centre for Addiction and Mental Health.

Albery, I.P., Strang, J., Gossop, M., Griffiths, P. 1999. Illicit drugs and driving: prevalence, beliefs and accident involvement among a cohort of current out-of-treatment drug users. Drug and Alcohol Dependence, 58, 197-204.

Asbridge, M., Mann, R.E., Smart, R.G., Stoduto, G., Vingilis, E., Beirness, D., Lamble, R. (in review). The effects of Ontario's administrative driver's licence suspension law on total driver fatalities: a multiple time series evaluation of Ontario and two control provinces. Transportation Research Part E: Logistics and Transportation Review.

Ashton, C.H., 2001. Pharmacology of cannabis: a brief review. British Journal of Psychiatry, 178, 101-106.

Bates, M.N., Blakely, T.A. 1999. Role of cannabis in motor vehicle crashes. Epidemiologic Reviews, 21(2), 222-232.

Beirness, D.J. 1993. Do we really drive as we live? The role of personality factors in road crashes. Alcohol, Drugs and Driving, 9(3-4), 129-143.

Beirness, D.J., Simpson, H.M., Desmond, K. 2003. The Road Safety Monitor 2002: Drugs and Driving. Ottawa: Traffic Injury Research Foundation.

Beirness, D., Vogel-Sprott, M. 1984. Alcohol tolerance in social drinkers – operant and classical conditioning effects. Psychopharmacology, 84, 393-397.

Berghaus, G., Guo, B.L., 1995. Medicines and driver fitness - findings from a meta-analysis of experimental studies as basic information to patients, physicians and experts. In: Kloeden, C.N., McLean, A.J. (Eds.), Alcohol, Drugs, and Traffic Safety - T'95: proceedings of the 13th International Conference on Alcohol, Drugs and Traffic Safety, Adelaide, pp. 295-300.

Brands, B., Sproule, B., Marshman, J. 1998. Drugs and Drug Abuse. Toronto: Centre for Addiction and Mental Health.

Brookoff, D., Cook, C.S., Williams, C., Mann, C.S. 1994. Testing reckless drivers for cocaine and marijuana. The New England Journal of Medicine, 331, 518-522.

Budd, R. D., Muto, J. J., Wong, J. K. 1989. Drugs of abuse found in fatally injured drivers in Los Angeles county. Drug and Alcohol Dependence, 23, 153-158.

Canadian Council of Motor Transport Administrators 2002. Jurisdictional survey of driving while impaired by drugs. www.ccmta.ca (Dec 2002).

Chait, L.D., Perry, J.L. 1994. Acute and residual effects of alcohol and marijuana, alone and in combination, on mood and performance. Psychopharmacology, 115, 340-349.

Chesher, G.B. 1995. Cannabis and road safety: an outline of the research studies to examine the effects of cannabis on driving skills and actual driving performance. In: The Effects of Drugs (Other than Alcohol) on Road Safety, Incorporating Collected Papers. Melbourne, LV North: Government Printer, pp. 67-96.

Christopherson, A.S., Gjerde, H., Bjorneboe, A., Sakshaug, J., Morland, J. 1990. Screening for drug use among Norwegian drivers suspected of driving under the influence of alcohol or drugs. Forensic Sciences International, 45, 5-14.

Christopherson, A.S., Morland, J. 1997. Drugged driving, a review based on the experience in Norway. Drug and Alcohol Dependence, 47, 125-135.

Cimbura, G., Lucas, D.M., Bennet, R.C., Donelson, A.C. 1990. Incidence and toxicological aspects of cannabis and ethanol detected in 1394 fatally injured drivers and pedestrians in Ontario (1982-1984). Journal of Forensic Science, 35(5), 1035-1041.

Coambs, R.B., McAndrews, M.P. 1994. The effects of psychoactive substances on workplace performance. In: Macdonald, S., Roman, P. (Eds.), Drug Testing in the Workplace. New York: Plenum Press.

Cohen, P., Sas, A. 1993. Ten years of cocaine. A follow-up study of 64 cocaine users in Amsterdam. Amsterdam: University of Amsterdam.

Cone, E.J., Huestis, M.A. 1993. Relating blood concentrations of tetrahydrocannabinol and metabolites to pharmacologic effects and time of marihuana usage. Therapeutic Drug Monitoring, 15, 527-532.

Connor, J., Whitlock, G., Norton, R., Jackson, R., 2001. The role of driver sleepiness in car crashes: a systematic review of epidemiological studies. Accident Analysis and Prevention, 33(1), 31-41.

Crouch, D.J., Birky, M.M., Gust, S.W., Rollins, D.E., Walsh, J.M., Moulden, J.V, Quinlan, K.E., Beckel, R.W. 1993. The prevalence of drugs and alcohol in fatally injured truck drivers. Journal of Forensic Sciences, 38, 1342-1353.

de Gier, J. J. 2000. Review of European investigations of illicit drug prevalence in road traffic. In: Alcohol, Drugs, and Traffic Safety - T`2000 Abstracts, 15th International Conference on Alcohol, Drugs and Traffic Safety, Stockholm, Sweden, pp. 278.

del Rió , M.C., Alvarez, F.J. 2000. Presence of illegal drugs in drivers involved in fatal road traffic accidents in Spain. Drug and Alcohol Dependence, 57(3), 177-182.

Deffenbacher, J.L., Huff, M.E., Lynch, R.S., Oetting, E.R., Salvatore, N.F. 2000. Characteristics and treatment of high-anger drivers. Journal of Counseling Psychology, 47(1), 5-17.

Denison, M.E., Paredes, A., Booth, J.B. 1997. Alcohol and cocaine interactions and aggressive behaviors. In: Galanter, M. (Ed.), Recent Developments in Alcoholism, Vol. 13: Alcohol and Violence: Epidemiology, Neurobiology, Psychology, Family Issues. New York, NY: Plenum Press, pp. 283-303.

Devane,W.A., Dysarz,F.A., Johnson, M.R., Melvin, L.S., Howlett, A.C. 1988. Determination and characterization of a cannabinoid receptor in rat brain. Molecular Pharmacology, 34, 605-613.

Donelson, A. 1988. The alcohol-crash problem. In: Laurence, M.D., Snortum, J.R., Zimring, F.E. (Eds.), The Social Control of Drinking and Driving. Chicago: University of Chicago Press, pp. 3-40.

Drummer, O.H. 1995. A review of the contribution of drugs in drivers to road accidents. In: Inquiry into the effects of drugs (other than alcohol) on road safety in Victoria, Incorporating Collected Papers. Melbourne: LV North, Government Printer, pp. 1-28.

Dussault, C., Brault, M., Bouchard, J., Lemire, A.M. 2002. The contribution of alcohol and other drugs among fatally injured drivers in Quebec: some preliminary results. In: D.R. Mayhew and C. Dussault (Eds.), Alcohol, Drugs and Traffic Safety – T`2002. Quebec: société de l'assurance automobile du Québec, pp. 423-430.

Everest, J.J., Tunbridge, R.J. 1990. The incidence of drugs in road accident fatalities in Great Britain, In: Perrine, M.W. (Ed.), Alcohol, Drugs, and Traffic Safety - T'89. Chicago, Illinois: National Safety Council, pp. 595-601.

Ferrara, S.D., Zancaner, S., Snenghi, R., Berto, F. 1990. Psychoactive drug involvement in traffic accidents in Italy. In: Perrine, M.W. (Ed.), Alcohol, Drugs, and Traffic Safety - T'89. Chicago: National Safety Council, pp. 260-264.

Ferrara, S.D., Giorgetti, R., Zancaner, S. 1994. Psychoactive substances and driving: state of the art and methodology. Alcohol, Drugs and Driving, 10, 1-55.

Foltz, R.L., McGinnis, K.M., Chinn, D.M. 1983. Quantitative measurement of Δ^9-tetrahydrocannabinol and two major metabolites in physiological specimens using capillary column gas chromatography negative ion chemical ionization mass spectrometry. Biomedical Mass Spectrometry, 10, 316-323.

Fortenberry, J.C., Brown, D.B., Shevlin, L.T. 1986. Analysis of drug involvement in traffic fatalities in Alabama. American Journal of Alcohol Abuse, 12(3), 257-267.

Gidron, Y., Davidson, K., Illia, R. 2001. Development and cross-cultural and clinical validation of a brief comprehensive scale for assessing hostility in medical settings. Journal of Behavioral Medicine, 24(1), 1-15.

Grotenhermen, F. 2003. Pharmacokinetics and pharmacodynamics of cannabinoids. Clinical Pharmacokinetics, 42(4), 327-360.

Hall, W., Solowij, N., 1998. Adverse effects of cannabis. Lancet, 352(9140), 1611-1616.

Harrison, E.R., Haaga, J., Richards, T. 1993. Self-reported drug use data: what do they reveal? American Journal of Drug and Alcohol Abuse, 19(4), 423-441.

Herscovitch, A.G. 1996. Cocaine. The Drug and the Addiction. New York: Gardner Press, Inc.

Hindin, R., McCusker, J., Vickers-Lahti, M., Bigelow, C., Garfield, F., Lewis, B. 1994. Radioimmuno-assay of hair for determination of cocaine, heroin, and marijuana exposure: comparison with self-report. International Journal of the Addictions, 29(6), 771-789.

Hollister, L.E. 1998. Health aspects of cannabis: revisited. International Journal of Neuropsychopharmcology, 1, 71-80.

Hollister, L.E., Gillespie, H.K., Ohlsson, A., Lindgren, J.-E., Wahlen, A., Agurell, S. 1981. Do plasma concentrations of Δ^9 tetrahydrocannabinol reflect the degree of intoxication? Journal of Clinical Pharmacology, 21, 171S-177S.

Horstmann, S., Hess, C.W., Bassetti, C., Gugger, M., Mathis, J. 2000. Sleepiness-related accidents in sleep apnea patients. Sleep, 23(3), 383-389.

Huestis, M.A., Hennigfield, J.E., Cone, E.J. 1992. Blood cannabinoids: II. Models for the prediction of time of marijuana exposure from plasma concentrations of Δ^9-tetrahydrocannabinol (THC) and 11-*nor*-9-carboxy-Δ^9-tetrahydrocannabinol (THCCOOH). Journal of Analytical Toxicology, 16, 283-290.

Hunter, C.E., Lokan, R.J., Longo, M.C., White, J.M., White, M.A. 1998. Appendices to: The prevalence and role of alcohol, cannabinoids, benzodiazepines and stimulants in non-fatal crashes. Forensic Science Department for Administrative and Information Services, South Australia.

Johns, A. 2001. Psychiatric effects of cannabis. British Journal of Psychiatry, 178, 116-122.

Jonah, B.A. 1990. Age differences in risky driving. Health Education and Research, 5, 139-149.

Jonah, B.A. 1997. Sensation seeking and risky driving: a review and synthesis of the literature. Accident Analysis and Prevention, 29(5), 651-665.

Kalant, H., Leblanc, A.E., Gibbins, R.J. 1971. Tolerance to, and dependence on, some non-opiate psychotropic drugs. Pharmacological Reviews, 23, 135-158.

Kapur, B. 1994. Drug-testing methods and interpretations of test result. In: Macdonald, S., Roman, P. (Eds.), Drug-testing in the workplace. New York: Plenum Press.

Kintz, P., Crimele, V., Mairot, F. Muhlmann, M., Ludes, B. 2000. Drug tests in 198 drivers implicated in non-fatal traffic accidents. Presse Medicale, 29(23), 1275-1278.

Lamers, C., Ramaekers, J. 2001. Visual search and urban city driving under the influence of marijuana and alcohol. Human Psychopharmacology: Clinical and Experimental Research, 16, 393–401.

Leirer, V.O., Yesavage, J.A., Morrow, D.G. 1991. Marijuana carry-over effects on aircraft pilot performance. Aviation and Space Environmental Medicine, 62, 221-227.

Liguori, A., Gatto, C.P., Jarrett, D.B. 2002. Separate and combined effects of marijuana and alcohol on mood, equilibrium and simulated driving. Psychopharmacology, 163, 399-405.

Logan, B.K., Schwilke, E.W. 1996. Drug and Alcohol use in fatally injured drivers in Washington state. Journal of Forensic Science, 41(3), 505-510.

Longo, M.C., Hunter, C.E., Lokan, R.J., White, J.M., White, M.A. 2000a. The prevalence of alcohol, cannabinoids, benzodiazepines and stimulants amongst injured drivers and their role in driver culpability. Part I: The prevalence of drug use in drivers and characteristics of drug positive group. Accident Analysis and Prevention, 32, 613-622.

Longo, M.C., Hunter, C.E., Lokan, R.J., White, J.M., White, M.A. 2000b. The prevalence of alcohol, cannabinoids, benzodiazepines and stimulants amongst injured drivers and their role in driver culpability. Part II: The relationship between drug prevalence and drug concentration, and driver capability. Accident Analysis and Prevention, 32, 623-632.

Macdonald, S., Mann, R., Chipman, M., Adlaf, E., Wells, S. 2001. The impact of treatment intervention on the rate of collisions and traffic violations for substance abuse groups. Presented at the 12th International Conference on the Reduction of Drug Related Harm, New Delhi, India, April 1-5.

Macdonald, S., Mann, R., Chipman, M., DeSouza, A. (in review a). Self-reports of driving after use of alcohol, cannabis and cocaine for substance abuse treatment clients and population controls. American Journal of Drug and Alcohol Abuse.

Macdonald, S., Anglin-Bodrug, K., Mann, R., Erickson, P., Hathaway, A., Chipman, M., Rylett, M. (in review b). Review: injury risk associated with cannabis and cocaine use. Drug and Alcohol Dependence.

Macdonald, S., Mann, R.E., Chipman, M. and Anglin-Bodrug, K. (in review c). Collisions and traffic violations of alcohol, cannabis and cocaine abuse clients before and after treatment. Accident Analysis and Prevention.

Maes, V., Charlier, C., Grenez, O., Verstraete, A., 1999. Drugs and medicines that are suspected to have a detrimental impact on road user performance. www.rosita.org, April 1, 2003.

Mann, R.E., Vogel-Sprott, M., Genest, M. 1983. Alcohol and cognitions: some preliminary observations. Journal of Studies on Alcohol, 44, 900-905.

Mann, R.E., Anglin, L., Rahman, S., Blessing, L.A., Vingilis, E.R., Larkin, E. 1995. Does treatment for substance abuse improve driving safety? A preliminary evaluation. In: Kloeden, C.N., McLean, A.J. (Eds.), Alcohol, Drugs and Traffic Safety – T'95. Adelaide, Australia: NHMRC Road Accident Research Unit, University of Adelaide, pp. 817-820.

Mann, R.E., Anglin, L., Vingilis, E.R., Larkin, E. 1993. Self-reported driving risks in a clinical sample of substance users. In: Utzelmann, H.D., Berghaus, G., Kroj, G. (Eds.), Alcohol, Drugs and Traffic Safety – T'92. Cologne, Germany: TUV Rheinland, pp. 860-865.

Mann, R.E., Smart, R.G., Stoduto, G., Vingilis, E., Beirness, D., Lamble, R. 2002. The early effects of Ontario's administrative driver's licence suspension law on driver fatalities with a BAC > 80 mg%. Canadian Journal of Public Health, 93, 176-180.

Mann, R.E., Macdonald, S., Stoduto, G., Bondy, S., Jonah, B., Shaikh, A. 2001. The effects of introducing or lowering legal per se blood alcohol limits for driving: an international review. Accident Analysis and Prevention, 33, 569-583.

Mann, R.E., Vogel-Sprott, M. 1981. Control of alcohol tolerance by reinforcement in nonalcoholics. Psychopharmacology, 75, 315-320.

Marquet, P., Delpla, P-A., Kerguelen, S., Bremond, J., Facey, F., Garnier, M., Guery, B., Lhermitte, M., Mathé, D., Pelissier, A.-L., Renaudeau, C., Vest, P., Seguela, J.-P. 1998. Prevalence of drugs of abuse in urine of drivers involved in road accidents in France: a collaborative study. Journal of Forensic Sciences, 43(4), 806-811.

Martin, B.R., Cone, E.J. 1999. Chemistry and pharmacology of cannabis. In: Kalant, H., Corrigall, W., Hall, W., Smart, R. (Eds), The Health Effects of Cannabis. Toronto: Addiction Research Foundation, pp. 21-68.

Masa, J.F., Rubio, M., Findley, L.J. 2000. Habitually sleepy drivers have a high frequency of automobile crashes associated with respiratory disorders during sleep. American Journal of Respiratory and Critical Care Medicine, 62(4), 1407-1412.

Mason, A.P., McBay, A.J. 1985. Cannabis: pharmacology and interpretation of effects. Journal of Forensic Science, 30, 615-631.

Mason, A.P., McBay, A.J. 1984. Ethanol, marijuana, and other drug use in 600 drivers killed in single-vehicle crashes in North Carolina, 1980-1981. Journal of Forensic Science, 29(4), 987-1026.

Maykut, M.O. 1985. Health consequences of acute and chronic marijuana use. Progress in Neuropsychopharmacology and Biological Psychiatry, 9, 209-238.

McBay, A.J. 1986. Drug concentrations and traffic safety. Alcohol Drugs and Driving, 2(3-4), 51-59.

McLean, S., Parsons, R.S., Chesterman, R.B., Dineen, R. Johnson, M.G., Davies, N.W. 1987. Drugs, alcohol and road accidents in Tasmania. Medical Journal of Australia, 147(1), 6-11.

Menkes, D.B., Howard, R.C., Spears, G.F.S., Cairns, E.R. 1991. Salivary THC following cannabis smoking correlates with subjective intoxication and heart rate. Psychopharmacology, 103, 277–9.

Mercer, G.W., Jeffery, W.K. 1995. Alcohol, drugs and impairment in fatal traffic accidents in British Columbia. Accident Analysis and Prevention, 27(3), 335-343.

Meulemanns, A., Hooft, P., Van Camp, L., De Vrieze, N., Buylaert, W., Verstraete, A., Vansnick, M., Baumans, P., Bruynseels, P., Charlier, C., Corne, L., Decroix, O., Desmet, K., D'Orio, V., Fox, A. Haenecaert, G., Hardy, M. A., Hassoun, A., Hubloue, I., Millan, G., Leyssens, L., Maes, V., Martens, F., Sabbe, M., Vanhaute, O., Vergnion, M., Wauters, A., Wenning, R. 1996. Belgian toxicology and trauma study: une étude portant sur la présence d'alcool, de médicaments et de drogues illicites chez des conducteurs victimes d'accidents de la route. Toxicological Society of Belgium and Luxembourg.

Moeller, M., Steinmeyer, S. and Aberl, F. 1999. Operational, User and Legal Requirements Across EU Member States for Roadside Drug Testing Equipment. Homburg, Germany: University Homburg/Saar, Institute for Legal Medicine.

Morland, J. 2000. Driving under the influence of non-alcohol drugs. Forensic Science Review, 12(1), 80-105.

Moskowitz, H. 1985. Marihuana and driving. Accident Analysis and Prevention, 17(4), 323-345.

Munro, S., Thomas, K.L., Abu-Shaar,M. 1993. Molecular characterization of a peripheral receptor for cannabinoids. Nature, 365, 61-64.

Nakahara,Y., Sekine, H., Cook, C. 1989. Confirmation of cannabis use: II. Determination of tetrahydrocannabinol metabolites in urine and plasma by HPLC with ECD. Journal of Analytical Toxicology, 13, 22-24.

National Cancer Institute of Canada 2001. Canadian Cancer Statistics, 1997. Ottawa: National Cancer Institute of Canada.

Nelson, D.B., Kotranski, L., Semann, S., Collier, K., Lauby, J., Feighan, K., Halbert, J. 1998. The validity of self-reported opiate and cocaine use by out-of-treatment drug users. Journal of Drug Issues, 28(2), 483-494.

Norris, F.H., Matthews, B.A., Riad, J.K. 2000. Characterological, situational, and behavioral risk factors for motor vehicle accidents: a prospective examination. Accident Analysis and Prevention, 32(4), 505-515.

Ogborne, A.C., Smart, R.G. 2000. Cannabis users in the general Canadian population. Substance Use and Misuse, 35(3), 301-311.

O'Kane, C.J., Tutt, D.C., Bauer, L.A. 2002. Cannabis and driving: a new perspective. Emergency Medicine, 14(3), 296-303.

Organisation for Economic Cooperation and Development 1968. Alcohol and Drugs. Paris: OECD Publications.

Orsay, E.M., Doan-Wiggins, L. Lewis, R., Lucke, R., RamaKrishnan, V. 1994. The impaired driver: hospital and police detection of alcohol and other drugs of abuse in motor vehicle crashes. Annals of Emergency Medicine, 24(10), 51-5.

Peel, H.W., Jeffrey, W.K. 1990. A report on the incidence of drugs and driving in Canada. Canadian Society of Forensic Sciences Journal, 23, 75-79.

Poklis, A., Maginn, D., Barr, J.L. 1987. Drug findings in 'Driving Under the Influence of Drugs' cases: a problem of illicit drug use. Drug and Alcohol Dependence, 20(1), 57-62.

Queensland Parliamentary Travelsafe Committee. 1999. Drug Driving in Queensland. Queensland, Australia: Queensland Legislative Assembly.

Robbe, H. 1998. Marijuana's impairing effects on driving are moderate when taken alone but severe when combined with alcohol. Human Psychopharmacology: Clinical and Experimental Research, 13, S70–S78.

Robbe, H., O'Hanlon, J. 1993. Marijuana and actual driving performance. US Dept Transportation, National Highway Traffic Safety Administration, p. 9.

Risser, D., Stichenwirth, M., Klupp, N., Schneider, B., Stimmpfl, T. Vycudilik, W., Bauer, G. 1998. Drugs and driving in Vienna. Austria Journal of Forensic Sciences, 43(4), 817-819.

Seymour, A., Oliver, J.S. 1999. Role of drugs and alcohol in impaired drivers and fatally injured drivers in the Strathclyde police region of Scotland, 1995-1998. Forensic Science International, 103(2), 89-100.

Simon, F., Corbett, C. 1996. Road traffic offending, stress, age, and accident history among male and female drivers. Ergonomics, 39(5), 757-780.

Smart, R.G., Fejer, D. 1973. Marihuana use among adults in Toronto. British Journal of Addiction, 68, 117-128.

Smart, R.G., Schmidt, W. 1969. Physiological impairment and personality factors in traffic accidents of alcoholics. Quarterly Journal of Studies on Alcohol, 30(2), 440-445.

Smart, R.G., Schmidt, W., Bateman, K. 1969. Psychoactive drugs and traffic accidents. Journal of Safety Research, 1, 67-73.

Smiley, A., 1999. Marijuana: on-road and driving-simulator studies. In: Kalant, H., Corrigall, W., Hall, W., Smart R. (Eds.), The Health Effects of Cannabis. Toronto: Addiction Research Foundation, pp. 173-191.

Soderstrom, C.A., Dischinger, P.C., Kerns, T.J., Trifillis, A.L. 1995. Marijuana and other drug use among automobile and motorcycle drivers treated at a trauma center. Accident Analysis and Prevention, 27(1), 131-135.

Stoduto, G., Vingilis, E., Kapur, B.M., Sheu, W.-J., McLellan, B.A., Liban, C.B. 1993. Alcohol and drug use among motor vehicle collision victims admitted to a regional trauma unit: demographic, injury, and crash characteristics. Accident Analysis and Prevention, 25(4), 411-420.

Sugrue, M., Seger, M., Dredge, G., Davies, D.J., Ieraci S., Baumann, A. Deane, S.A., Sloane, D. 1995. Evaluation of the prevalence of drug and alcohol abuse in motor vehicle trauma in south western Sydney. Australia and New Zealand Journal of Surgery, 65(12), 853-856.

Terhune, K.W., Fell, J.C. 1982. The role of alcohol, marijuana and other drugs in the accidents of injured drivers. Abstracts and Reviews in Alcohol and Driving, 3(6), 3-6.

Thompson, L., Cone, E. 1987. Determination of delta-9-tetrahydrocannabinol in human blood and saliva by high-performance liquid chromatography with amperometric detection. Journal of Chromatography, 421, 91-97.

Turner, C.F., Lessler, J.T., Gfroerer, J.C. (Eds.) 1992. Survey Measurement of Drug Use: Methodological Studies. Washington, DC: Department of Health and Human Services.

Tzambazis, K., Stough, C. 2002. The SFST and driving ability. Are they related? In: D.R. Mayhew and C. Dussault (Eds.), Alcohol, Drugs and Traffic Safety – T'2002. Quebec: société de l'assurance automobile du Québec.

Vavrik, J. 1997. Personality and risk-taking: a brief report on adolescent male drivers. Journal of Adolescence, 20(4), 461-465.

Veneziano, C., Veneziano, L. 1992. Psychosocial characteristics of persons convicted of driving while intoxicated. Psychological Reports, 70(3), 1123-1130.

Verstraete AG. 2000. Perspectives for the detection of cannabis in breath. Proceedings of the 15th International Council on Alcohol, Drugs and Traffic Safety, May 22–26, Stockholm, Sweden: Economy Press, pp. 337–341.

Vingilis, E., Macdonald, S. 2002. Review: drugs and traffic collisions. Traffic Injury Prevention, 3, 1-11.

Vogel-Sprott, M. 1992. Alcohol Tolerance and Social Drinking. New York: The Guilford Press.

Walsh, G., Mann, R.E. 1999. On the high-road: driving under the influence of cannabis in Ontario. Canadian Journal of Public Health, 90, 260-263.

Walsh, J.M., Danziger, G., Cangianelli, L.A., Koehler, D.B. 2002. Driving under the influence of Drugs (DUID) Legislation in the United States. Bathesda, Maryland: The Walsh Group and The American Bar Association's Standing Committee on Substance Abuse, November 2002.

Wells-Parker, E., Cosby, P.J., Landrum, J.W. 1986. A typology of drinking driver offenders: methods for classification and policy implications. Accident Analysis and Prevention, 18(6), 443-453.

Wiesenthal, D.L., Hennessey, D., Gibson, P.M. 2000. The Driving Vengeance Questionnaire (DVQ): The development scale to measure deviant drivers' attitudes. Violence Victimization, 15(2), 115-136.

Williams, A.F., Peat, M.A., Crouch, D.J. 1985. Drugs in fatally injured young male drivers. Public Health Reports, 100, 19-25.

Zack, M., Vogel-Sprott, M. 1993. Response outcomes affect the retention of behavioural tolerance to alcohol: information and incentive. Psychopharmacology, 113, 269-273.

Appendix A

Criminal Code of Canada

253. Every one commits an offence who operates a motor vehicle or vessel or operates or assists in the operation of an aircraft or of railway equipment or has the care or control of a motor vehicle, vessel, aircraft or railway equipment, whether it is in motion or not,

(a) while the person's ability to operate the vehicle, vessel, aircraft or railway equipment is impaired by alcohol or a drug; or

(b) having consumed alcohol in such a quantity that the concentration in the person's blood exceeds eighty milligrams of alcohol in one hundred millilitres of blood.

R.S., 1985, c. C-46, s. 253; R.S., 1985, c. 27 (1st Supp.), s. 36, c. 32 (4th Supp.), s. 59.

Definitions

254. (1) In this section and sections 255 to 258,

"analyst" means a person designated by the Attorney General as an analyst for the purposes of section 258;

"approved container" means

(a) in respect of breath samples, a container of a kind that is designed to receive a sample of the breath of a person for analysis and is approved as suitable for the purposes of section 258 by order of the Attorney General of Canada, and

(b) in respect of blood samples, a container of a kind that is designed to receive a sample of the blood of a person for analysis and is approved as suitable for the purposes of section 258 by order of the Attorney General of Canada;

"approved instrument" means an instrument of a kind that is designed to receive and make an analysis of a sample of the breath of a person in order to measure the concentration of alcohol in the blood of that person and is approved as suitable for the purposes of section 258 by order of the Attorney General of Canada;

"approved screening device" means a device of a kind that is designed to ascertain the presence of alcohol in the blood of a person and that is approved for the purposes of this section by order of the Attorney General of Canada;

"qualified medical practitioner" means a person duly qualified by provincial law to practise medicine;

"qualified technician" means,

(a) in respect of breath samples, a person designated by the Attorney General as being qualified to operate an approved instrument, and

(b) in respect of blood samples, any person or person of a class of persons designated by the Attorney General as being qualified to take samples of blood for the purposes of this section and sections 256 and 258.

Testing for presence of alcohol in the blood
(2) Where a peace officer reasonably suspects that a person who is operating a motor vehicle or vessel or operating or assisting in the operation of an aircraft or of railway equipment or who has the care or control of a motor vehicle, vessel or aircraft or of railway equipment, whether it is in motion or not, has alcohol in the person's body, the peace officer may, by demand made to that person, require the person to provide forthwith such a sample of breath as in the opinion of the peace officer is necessary to enable a proper analysis of the breath to be made by means of an approved screening device and, where necessary, to accompany the peace officer for the purpose of enabling such a sample of breath to be taken.

Samples of breath or blood where reasonable belief of commission of offence
(3) Where a peace officer believes on reasonable and probable grounds that a person is committing, or at any time within the preceding three hours has committed, as a result of the consumption of alcohol, an offence under section 253, the peace officer may, by demand made to that person forthwith or as soon as practicable, require that person to provide then or as soon thereafter as is practicable

(a) such samples of the person's breath as in the opinion of a qualified technician, or

(b) where the peace officer has reasonable and probable grounds to believe that, by reason of any physical condition of the person,

(i) the person may be incapable of providing a sample of his breath, or

(ii) it would be impracticable to obtain a sample of the person's breath,

such samples of the person's blood, under the conditions referred to in subsection (4), as in the opinion of the qualified medical practitioner or qualified technician taking the samples

are necessary to enable proper analysis to be made in order to determine the concentration, if any, of alcohol in the person's blood, and to accompany the peace officer for the purpose of enabling such samples to be taken.

Exception
(4) Samples of blood may only be taken from a person pursuant to a demand made by a peace officer under subsection (3) if the samples are taken by or under the direction of a qualified

medical practitioner and the qualified medical practitioner is satisfied that the taking of those samples would not endanger the life or health of the person.

Failure or refusal to provide sample
(5) Every one commits an offence who, without reasonable excuse, fails or refuses to comply with a demand made to him by a peace officer under this section.

Only one conviction for failure to comply with demand
(6) A person who is convicted of an offence committed under subsection (5) for a failure or refusal to comply with a demand made under subsection (2) or paragraph (3)(a) or (b) in respect of any transaction may not be convicted of another offence committed under subsection (5) in respect of the same transaction.

R.S., 1985, c. C-46, s. 254; R.S., 1985, c. 27 (1st Supp.), s. 36, c. 1 (4th Supp.), ss. 14, 18(F), c. 32 (4th Supp.), s. 60; 1999, c. 32, s. 2(Preamble).

Punishment
255. (1) Every one who commits an offence under section 253 or 254 is guilty of an indictable offence or an offence punishable on summary conviction and is liable,

(a) whether the offence is prosecuted by indictment or punishable on summary conviction, to the following minimum punishment, namely,

(i) for a first offence, to a fine of not less than six hundred dollars,

(ii) for a second offence, to imprisonment for not less than fourteen days, and

(iii) for each subsequent offence, to imprisonment for not less than ninety days;

(b) where the offence is prosecuted by indictment, to imprisonment for a term not exceeding five years; and

(c) where the offence is punishable on summary conviction, to imprisonment for a term not exceeding six months.

Impaired driving causing bodily harm
(2) Every one who commits an offence under paragraph 253(a) and thereby causes bodily harm to any other person is guilty of an indictable offence and liable to imprisonment for a term not exceeding ten years.

Impaired driving causing death

(3) Every one who commits an offence under paragraph 253(a) and thereby causes the death of any other person is guilty of an indictable offence and liable to imprisonment for life.

Previous convictions

(4) Where a person is convicted of an offence committed under paragraph 253(a) or (b) or subsection 254(5), that person shall, for the purposes of this Act, be deemed to be convicted for a second or subsequent offence, as the case may be, if the person has previously been convicted of

(a) an offence committed under any of those provisions;

(b) an offence under subsection (2) or (3); or

(c) an offence under section 250, 251, 252, 253, 259 or 260 or subsection 258(4) of this Act as this Act read immediately before the coming into force of this subsection.

R.S., 1985, c. C-46, s. 255; R.S., 1985, c. 27 (1st Supp.), s. 36; 1999, c. 32, s. 3(Preamble); 2000, c. 25, s. 2.

Aggravating circumstances for sentencing purposes

255.1 Without limiting the generality of section 718.2, where a court imposes a sentence for an offence committed under this Act by means of a motor vehicle, vessel or aircraft or of railway equipment, evidence that the concentration of alcohol in the blood of the offender at the time when the offence was committed exceeded one hundred and sixty milligrams of alcohol in one hundred millilitres of blood shall be deemed to be aggravating circumstances relating to the offence that the court shall consider under paragraph 718.2(a).

1999, c. 32, s. 4(Preamble).

Warrants to obtain blood samples

256. (1) Subject to subsection (2), if a justice is satisfied, on an information on oath in Form 1 or on an information on oath submitted to the justice under section 487.1 by telephone or other means of telecommunication, that there are reasonable grounds to believe that

(a) a person has, within the preceding four hours, committed, as a result of the consumption of alcohol or a drug, an offence under section 253 and the person was involved in an accident resulting in the death of another person or in bodily harm to himself or herself or to any other person, and

(b) a qualified medical practitioner is of the opinion that

(i) by reason of any physical or mental condition of the person that resulted from the consumption of alcohol or a drug, the accident or any other occurrence related to or resulting from the accident, the person is unable to consent to the taking of samples of his or her blood, and

(ii) the taking of samples of blood from the person would not endanger the life or health of the person,

the justice may issue a warrant authorizing a peace officer to require a qualified medical practitioner to take, or to cause to be taken by a qualified technician under the direction of the

qualified medical practitioner, the samples of the blood of the person that in the opinion of the person taking the samples are necessary to enable a proper analysis to be made in order to determine the concentration, if any, of alcohol or drugs in the person's blood.

Form
(2) A warrant issued pursuant to subsection (1) may be in Form 5 or 5.1 varied to suit the case.

Information on oath
(3) Notwithstanding paragraphs 487.1(4)(b) and (c), an information on oath submitted by telephone or other means of telecommunication for the purposes of this section shall include, instead of the statements referred to in those paragraphs, a statement setting out the offence alleged to have been committed and identifying the person from whom blood samples are to be taken.

Duration of warrant
(4) Samples of blood may be taken from a person pursuant to a warrant issued pursuant to subsection (1) only during such time as a qualified medical practitioner is satisfied that the conditions referred to in subparagraphs (1)(b)(i) and (ii) continue to exist in respect of that person.

Facsimile to person
(5) Where a warrant issued pursuant to subsection (1) is executed, the peace officer shall, as soon as practicable thereafter, give a copy or, in the case of a warrant issued by telephone or other means of telecommunication, a facsimile of the warrant to the person from whom the blood samples were taken.

R.S., 1985, c. C-46, s. 256; R.S., 1985, c. 27 (1st Supp.), s. 36; 1992, c. 1, s. 58; 1994, c. 44, s. 13; 2000, c. 25, s. 3.

Appendix B

Table 1: Current regulations in European Union countries concerning drugged-driving

	Austria	**Belgium**	**Czech Republic**	**Denmark**
DUI of Drugs -specific legislation		Art.35,37bis,61bis,61ter,63 3° en 4° (Traffic Law) Law of 16.03.´68; modified on 16.03.´99, in effect since 30.03.´99		Danish Traffic Act §54, 1
- general legislation	§5 StVO (Traffic Law)		-Art. No 89, Sec. 13 (Penal Law) -Law No. 65/1994, §201 (Penal Code) -Law No. 124/1993, §30 (Misdemeanour Act) -Law No. 12/1997, §§6,9 (Traffic Law) -Law No. 40/1995, §6 (Law about protection from alc. and drug abuse) -Law No. 167/1998; (Substances of abuse)	
Substances, Limits	Drugs of abuse as specified by the Law on DOA (´97)	THC (2 ng/ml), MOR (20 ng/ml), AMP, MDMA, MDEA, MBDB, COC, BZE (all 50 ng/ml) Conc. in plasma	No drugs are mentioned	Psychoactive subst.
Exemptions?	No	No	No	No
Future Changes?	Yes	No	No	No

	France	Finland	Germany	Greece
DUI of Drugs -specific legislation			§24a StVG (Traffic Law), changed on August 1st, '98	L 2696/99, Sect. 42 (Traffic Law), in effect since May 23th, '99 Minist. decisions -13382 φ. 705.11/4δ/25-10-77 -1330 φ 705.11/4ξΘ/15-2-85
- general legislation	Public Health Code L626, L630 -Driving while impaired -Offence of putting somebody in danger by using drugs on the road	Penal Code 23 (since '77); impairment has to be demonstrated, although a significant amount of drugs has been measured in blood	§§316, 315c StGB (Penal Law)	
Substances, Limits	Drugs of abuse, and plants listed on an updated list	Subst. which can cause impairment of driving performance	THC, MOR, BZE, AMP, MDE, MDMA; pos detect. in blood -For the penal law: alcohol and/or drugs acting on the CNS	Toxic substances
Exemptions?	No	No	Yes	No
Future Changes?	Yes	No	No, but the list of substances will be updated	No

	Iceland	Ireland	Italy	Luxembourg
DUI of Drugs -specific legislation		Road Traffic Act, Sect. 49 (criminal law); in effect since '61	New Highway Code Law 285/1992 Art. 186, 187 (Traffic Law)	
- general legislation	Traffic Law No. 50/1987, Sect. VII, Art. 44, Paragr. 2			Legislation for which an impairment of driving performance has to be demonstrated
Substances, Limits	No substances	All drugs	Stupefying and psychotrop. subst., alcohol	A significant amount of drugs has been measured in drivers blood
Exemptions?	No	No	No	No
Future Changes?	No	No	No	No

	The Netherlands	Norway	Poland	Slovenia
DUI of Drugs -specific legislation		§ 22.1, Road Traffic Act (Penal Law) in effect since '59		Road Traffic Safety Act, §118 (Traffic Law); in effect since '98
- general legislation	Traffic Act, Art. 8, Sect. 1 (Criminal Law); in effect since Nov. '74, last change Oct. '87		Covering DUI of alc. and drugs 1. Penal Code ('98), Chapt. XXI Offences against safety in traffic, Art. 178 2. Traffic Law -On Traffic Law Act (30.06.'97), Art. 45 -Traffic Regulations, Art. 126,127	
Substances, Limits	Any subst. that might influence driving behaviour	All psychoactive drugs	Drugs of abuse, substances similar in action to alcohol	Hypnotics, psychoactive medicines and other psychoact. subst. which diminish drivers ability
Exemptions?	No	No	No	No
Future Changes?	Yes	No, but the government has proposed to lower the BAC limit to 0.02%	No	No

	Spain	Switzerland	UK
DUI of Drugs -specific legislation	Penal Code: Title XVII: Offences against collective safety Chapter IV: Offences against traffic safety; Art. 379 (Penal Law)		
- general legislation		Art. 31, Sect. 2 StVG Art. 90, Sect. 1,2 StVG Art. 2,1 VRV	Road Traffic Act '88, Sect. 4 (Traffic Law)
Substances, Limits	Toxic drugs, narcotic and psychotropic substances; No limits	Drugs and drugs of abuse, no list Alcohol 0.80 g/kg in whole blood	All substances causing impairment (only alcohol is specifically mentioned)
Exemptions?	No	No	No
Future Changes?	No	Yes	No

Source: Moeller, Steinmeyer, Aberl, 1999.

Table 2: Future legislative amendments planned by European Union countries based on Moeller, et al, 1999.

	Austria	France	The Netherlands	Switzerland
Regulations which will be changed	Amendment of StVO (Traffic Law) in discussion Amendment time: not known yet	Penal Law: detection of illicit drugs in drivers involved in a fatal accident in an epidemiological aim (but the results will be sent to the prosecutor) Voted March '99, will be applied Jan 2000	On a policy level, the introducing of a specific legislation on DUI of (prescribed) drugs is discussed (related to the Traffic Act, Art. 8, Sect. 1)	Revision of Art. 31, Sect. 2 SVG Art. 55, Sect. 1-6 SVG Art. 91, Sect. 1-3 SVG Amendment time: Approx. in 2001
Substances, Limits	The substances are still in discussion, but no limits	OPI, COC, CAN, AMP; BZD are in discussion, but should probably not involved No legal limits (detection)	In discussion: a system of cut-off values	The Federal Council (the Government) will fix which subst. and at which conc. in blood the driving ability definitely has to be denied
Exemptions	Unknown	Actually not	Unknown	Unknown

Source: Moeller, Steinmeyer, Aberl, 1999.